EVALUATION OF FOLIAGE PLANTS FOR INTERIOR PLANTSCAPING

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"Evaluation of foliage plants for interior plantscaping"** is a bonafide record of research work done by me during the course of research and this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellanikkara

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CERTIFICATE

Certified that this thesis entitled **"Evaluation of foliage plants for interior plantscaping"** is a record of research work done independently by Mr. Alex, R. under my guidance and supervision and that it has not previously formed the basis for award of any degree, fellowship or associateship to him.

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"The flower sweetens the air with its perfume; yet its last service is to offer itself to thee"
-Rabindranath Tagore

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Place: Vellanikkara
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(Alex, R)

ABBREVIATIONS

%	-	per cent
μ	-	micron
μg	-	microgram
^{0}C	-	Degree Celsius
AD	-	After Christ
BC	-	Before Christ
CD (0.05)	-	Critical Difference at 5 per cent level
APTI	-	Air Pollution Tolerance Index
FP	-	Fan and pad greenhouse
OV	-	Open ventilated greenhouse
LL	-	Low light intensity (<800 lux)
ML	-	Medium light intensity (800-2000 lux)
HL	-	High light intensity (>2000 lux)
SL	-	Supplementary light (800-2000 lux)
A/C	-	Air conditioned with supplementary light (800-2000 lux)
Tcfu	-	Total colony forming units
NS	-	Non-significant
cm	-	centimeters
cm^2	-	square centimeter
cv.	-	cultivar
et al.	-	and others
Fig.	-	Figure
FYM	-	Farm Yard Manure
g	-	gram
g/m^2	-	gram per square meter
mg/g	-	milligram per gram
i.e.	-	that is
nos.	-	Numbers
pH	-	Power of hydrogen ion
ppm	-	parts per million
RH	-	Relative Humidity
₹	-	Rupees
viz.,	-	namely
PCA	-	Plate Count Agar

Dedicated to

Dream INDIA 2020

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Introduction

1. INTRODUCTION

Flowers are the manifestations of god's love. But in today's world due to various reasons like industrialization and urbanization, people find it difficult to interact with plants and nature. In order to reduce the gap, growing plants indoor is a right way to promote interaction. But we need to consider many factors like space, light etc without which no plants can survive. In this scenario, the foliage plants are found to be a good solution as they need only minimum space and light for their survival.

Foliage plants include all plants grown for their attractive leaves rather than flowers or fruits. In other words foliage plants are those with attractive foliage that are able to survive and grow indoors. They are used as living plants for interior plantscaping. Foliage plants, in common terminology, are called house plants (Chen *et al.,* 2002). The use of foliage plants for interior decoration or interior plantscaping has become an integral part of contemporary design, playing an important role in our life (Manaker, 1997). Interior plantscaping involves the use of plant materials to improve the appearance of the indoor environment. It usually implies a complex design involving many plants (Bionda and Noland, 2006).

The role of plants as live air purifiers and those which reduce psychological stress associated with high density population is becoming more relevant. Ornamental foliage plants are widely used in interiorscaping due to their adaptation to low light levels after appropriate acclimatization (Scuderi *et al.*, 2010).

Foliage plants from the world's tropical or subtropical regions provide the basis for today's foliage plant industry. Every year a lot of genera are being included in the list of foliage plants and the fact that no single genus exceeds 10 per cent of the market indicates increased diversification in foliage plant production. The wholesale value of foliage plants in the US increased from $ 13 million in 1949 to $ 574 million in 2000 (Chen *et al.*, 2002). Plants from at least 100 genera and 1000 species are grown as foliage plants. These plants have widely diverse forms, patterns of foliar variegation, and colours. Based on their appearance, foliage plants can be simply categorized into three groups: green-leaf, variegated-leaf, and flowering foliage plants (Chen *et al.*, 2005).

Foliage plants consist of tropical and subtropical plants selected for their ability to be grown indoors. They are commonly referred to as house plants because of their wide use in residential homes. The colour and interest provided by their leaves make them attractive to people. Some foliage plants produce interesting or colourful flowers that add to their value.

The foliage ornamental industry has created a major breakthrough in floriculture business in recent years. Dependence of potted plants especially foliage is growing very fast on account of non-availability of ground space in cities.

Common indoor plants provide a valuable weapon in the fight against rising levels of indoor air pollution. Those plants in office or home are not only decorative, but are surprisingly useful in absorbing potentially harmful gases and cleaning the air inside modern buildings. Since most of the people spend much of their time indoors, they are exposed to air pollution. Plants can reduce complaints of minor ailments, generally improve the feeling of well-being and also reduce stress levels.

In some circumstances, poor indoor air quality may pose serious health risks, particularly in susceptible individuals. The air pollution tolerance index (APTI) in indoor plants can be used to maintain the quality of the indoor air for the occupants of the building. APTI indices will help to classify plants according to their tolerance to air pollution. We can even select pollution indicator plants from the sensitive group and tolerant ones that can survive even if the indoor atmosphere is slightly polluted.

With over 300 million middle and higher income population, India is the world's 2nd largest consumer base and fastest growing retail destination. Flowers and foliage plants consumption is growing at a whopping 30 per cent per annum and numerous festivals, along with increasing modernisation and per capita income make India a floral super power of the future (Anon, 2012). Kerala, already a biodiversity hub, can lead the country by evaluating and introducing many foliage plants which it possesses in enormous numbers.

With this background, the present study "Evaluation of foliage plants for interior plantscaping" was undertaken to evaluate the performance of foliage ornamentals under two different growing conditions, to assess their potential for interior plantscaping, to compute their Air Pollution Tolerance Index and ability to remove airborne microbes and dust from indoor environment.

Review of Literature

2. REVIEW OF LITERATURE

Flowers connect us directly to Mother Nature. By looking at them, one feels a sense of contentment and compassion which leads to reduction of worries and anxiety (Sharma and Sharma, 2010). As a result of urbanization, the plants battle with man for space and often get defeated. So growing indoor plants paves the way to reconnect man to nature. But all plants cannot be grown indoors as they have to adapt to the limited conditions inside. In these respects, the foliage plants with their variegations not only adapt well to the conditions but would also enhance the aesthetic and positive effects.

Most of the foliage plants in trade are native to the tropics which enhance the possibility of their successful cultivation in many parts of the country. However, the potential of foliage plant production on a commercial scale has not been exploited fully. The market of most of the foliage plants is year round and the increased demand for foliage plants both in the international and domestic markets calls for considerable augmentation of local production (Swarup, 1993). Further, most of the species are yet to be identified and evaluated for the purpose of interior plantscape for their cultural requirements as well as their beneficial effects. The available literature on foliage plants pertinent to this study is reviewed here under.

2.1. History of foliage plants

The history of foliage plants is believed to have begun from 3,500 years ago when plants were grown in containers during the ancient empires of the Sumerians and the Egyptians. However, there is no known record as to precisely when humans first started to use foliage plants for interior decoration. The reason for the early use of foliage plants might be due to their varied forms, styles, colours and textures. Although the correct beginning is not clear, it is known that during the Renaissance, collection and introduction of plants flourished and huge number of species had been introduced from east into Europe in the 15^{th} century (Smith and Scarborough, 1981).

It is described that the eighteenth and early nineteenth centuries were the greatest botanical era-a time when plants from India, America, Africa, and Australia were collected and brought into cultivation in Europe and large scale productions were made to meet the demands of plant lovers. The protected environment of the Wardian case (invented in 1833) dramatically increased the number of living specimens that survived the long sailing voyage from the tropics to Europe. The availability of diverse and exotic plants that could tolerate varied environmental conditions promoted the use of living plants indoors and gave birth to the modern foliage plant industry.

Hybridization of *Dieffenbachia* species dates back to almost the same period as the hybridization of peas by Gregor Mendel (Chen *et al.*, 2005). The oldest known *Dieffenbachia* hybrid is 'Bausei', a cross between *D. maculata* and *D. weirii* made in 1870 in the greenhouses of the Royal Horticultural Society of London at Chriswick. Within a decade, shiploads of foliage plants were transported across the nations and this may be considered as the beginning of globalization of foliage plant production. As a result of plant exploration, most foliage plants have been introduced and they were found to be originated from tropical and subtropical regions. Obviously, a few are mutants and the future of foliage plants lies in plant breeding and related new technologies to provide new and improved plants to satisfy the demand.

2.2. Scope of foliage plants in floriculture industry

According to FloraHolland (2011), among the total turnover and supply of floricultural products during 2010 (€ 4130 million), the foliage indoor plants alone contribute € 1445 million (₹ 99.23 billion) in the world floricultural trade. Their share also seems to increase by 4.4 per cent from the last year sales. Some of the important indoor foliage plants that top the world rank lists in 2010 are Anthurium, *Kalanchoe, Dracaena, Ficus, Spathiphyllum, Hedera, Begonia, Chrysalidocarpus lutescens* and *Zamioculcas.*

Though India faces some sort of downturn in the export of floricultural products during the recent years, dried flowers and foliages have been forming larger part of floricultural products exported from India (Sarkar, 2011). The recent data show that floricultural products (live trees and other piants, bulbs, roots and the like; cut flowers and ornamental foliage) exports from India stands at ₹ 28,645 Lakhs during 2010-11 fiscal years. In the same period, the imports valued ₹ 4548 Lakhs (DGCIS, 2011). The trend shows that India has been slowly rising its pace in the international trade. As the foliage plant industry is concerned, during 2008-09, more than 39 per cent of the total export from India was contributed by foliage either as fresh or dry.

Kerala, God's own land, already gifted with diverse varieties of flora and fauna, is having a number of native species and varieties of foliage waiting to be evaluated and introduced to the market. When we deal with flower crops, market demands are season bound and infrastructure requirements for the industry is yet to pick up the pace. In this regard, foliage plants can be provided with year round income for the growers and demand will be both domestic as well as international. Kerala with its advantage of humid tropical climate can also be served as a research and development hub as well as a production centre of foliage plants for whole of India to meet domestic and international demands. So there is enormous scope for the foliage plants market yet to be tapped in the state provided, good quality production materials and financial assistance for its hi-tech production are available. Floriculture zonation of Kerala by Rajeevan (1999), presents plane land including coastal areas suitable for its commercial production.

2.3. Evaluation for landscaping and interiorscaping

A complete foliage plant cycle comprises of plant propagation via tissue culture, rooting of cuttings, or seed germination; production of marketable plants from tissue cultured liners, rooted cuttings, or seedlings; and postproduction plant care, including shipment, interiorscape installation, and maintenance (Chen *et al.*, 2005). In due course, the plants were compelled to undergo different conditions and environments starting from production site to indoor conditions irrespective of their response to these conditions finally causing great loss to growers. So evaluating the performance of foliage plants of commercial importance in different conditions will harness the benefits to growers. Thus various foliage plants can be introduced into the market and growers will also have wide range of choice for their gardens and interiors.

Over 300 cultivars of foliage plants are grown commercially in Florida, used for interior decorative purposes (McConnell and Conover, 1973). Successful adaptation to home environments depends on the ability of a plant to maintain its aesthetic appeal under low light intensity. Research and general evaluations of foliage plant utilization in low light areas indicate that plants belonging to the genera *Aglaonema, Aspidistra, Chamaedorea, Dracaena, Ficus, Maranta, Peperomia, Philodendron, Sansevieria* and *Spathiphyllum* will remain attractive for long periods in most interior environments.

Dieffenbachia and *Aglaonema* species and cultivars have been regarded as important tropical foliage plants because of their attractive foliar variegation, adaptability to interior environments, and ease of production (Henny *et al.*, 1987).

VanUfflen (1989) described *Pittosporum tobira* (Thumb) Ait, Japanese Pittosporum, a popular evergreen shrub that is used as a landscape plant and occasionally as a potted plant for interiorscapes. Kennedy (1993) described a new species *Calathea liesneri* of family Marantaceae which was valued for its peculiar leaf characteristics.

Philodendrons are among the most common and easy-to-grow house plants. The diverse groups of plants range from vines with 3-inch heart shaped green leaves to vines with leaves 3 feet long. Some types have glossy solid green leaves, others have velvet textured patterned leaves, while some have deep red leaves and stems. Most common types are vines, some are self-heading. Dracaenas can grow upto 2 to 10 feet tall, depending on the cultivar. It is easy to maintain these plants at shorter height if desired. Upright types will usually be not more than 2 feet wide. Dracaenas are grown for their strap-shaped foliage which is colourfully striped in many of the cultivars. Scheffleras are usually 2 to 3 feet tall when sold, and grow to 8 feet or more in height. It is possible to prune them to maintain a lower height. Scheffleras are grown for the attractive patterns formed by their leaves, and for their tall and shrubby form (Russ and Pertuit, 2001).

Stamps (2002) reported herbaceous plants like *Aspidistra elatior* (cast iron plant), and *Cordyline* spp. becoming as cut foliage crops. He also reported that several species and cultivars of asparagus like *Asparagus densiflorus* Jessop 'Myers' (foxtail fern), *Aparagus densiflorus* 'Sprengeri' (Sprengeri fern), *Asparagus macowanii* Bak (Ming fern) and *Asparagus virgatus* Bak (tree fern) are popular as speciality plants.

Traditionally, anthuriums with colourful inflorescence have been grown for cut flowers, with the introduction of compact interspecific hybrids through breeding and the selection of somaclonal variants. *Anthurium warocqueanum*, characterised by velvety leaves with silvery grey venation is mainly valued for its foliage (Boyce, 1995). A series of potted anthurium cultivars have been released (Chen *et al.*, 2003). Molfino (2003) stated that potted anthuriums become an important flowering foliage plant because of its long-lasting, colourful flowers and deep green, shiny, arrow-shaped leaves apart from its demand as cut flower.

Export value of anthurium pot plants in Dutch auctions is reported to be increased by 23 per cent in 2003.

Castro *et al.*, (2010) evaluated ten native Anthurium accessions for their ornamental foliage potential, through morphological descriptors and revealed that all ten accessions possess good foliage characteristics for commercial exploration. Gayathri (2008) evaluated ten varieties of each cut flower and potted plant type of anthurium and in two different climatic regimes and found significant different between the locations with respect to plant characters. Maximum temperature was found to be positively correlated and relative humidity negatively correlated with plant growth parameters and other weather factors were not significant.

Chen and Henny (2003) reported the results of evaluation of *Zamioculcas zamiifolia* (ZZ) for four years and stated that it is an important emerging foliage plant due to its aesthetic appearance, ability to tolerate low light and drought, and resistance to diseases and pests.

Gonçalves *et al.* (2005) evaluated costus and found six species as the most adapted for indoor cultivation and they were: *C. curvibracteatus, C. amazonicus, C. erythrophyllus, C. malortianus, C. cuspidatus and C. lasius.*

Dong *et al.* (2009) collected and evaluated several ornamental ferns in Beijing area and found that *Adiantum capillus-junosis, Aleuritopteris argentea, Gymnocarpium disjunctum* and *Polystichum craspedosorum* could be used as potted plants because of their special frond characteristics. Also, several species were found to be evergreen when grown in glasshouses. Furthermore, foliage of *Polystichum craspedosorum* was found to be useful as cut foliage in the industry.

Codiaeum variegatum (L.) Blume is a popular ornamental foliage plant that displays an anomalous range of variations in its leaf size, shape and colour pattern. Pillay and Venkataratnam (1958) opined that *Codiaeum variegatum* is valued for their colourful foliage and described some of the outstanding varieties. Crotons are shrubs that can grow upto six feet or more in height and width. Leaf colours range from red, orange and yellow to green with all combinations of variegated colours. Leaf shapes vary from broad and elliptical to narrow and almost linear. Leaf blades range from flat to cork-screw-shaped.

Mollick *et al.* (2011) investigated the diversity of leaf phenotype in croton cultivars with a numerical taxonomic approach. Among the numerical parameters tested, the leaf index that is the ratio of leaf length to leaf width showed the highest variability. High coefficient of variation values were observed in petiole length, leaf area and leaf quarter width. In contrast with leaf morphology, the composition of leaf pigments that contribute to leaf colouration did not show diversity. Based on the analyses of the leaf parameters, they clustered the croton cultivars into four major groups.

Twenty-seven foliage plant species belonging to ten different families were evaluated for their performance under field conditions and emphasized the use of foliage plants as cut foliage in flower arrangements and interior decorations (Eapen, 2003). Kumar and Bhattacharjee (2003) reported twenty-eight species of foliage plants as potential cut greens with their production and environmental requirements.

2.4. Production systems for foliage plants

Polyhouse is a framed structure cladded with polyethylene film which can provide the favourable conditions for the growth of the plants in several ways, *viz.*, favourable environmental condition, protection from heavy winds, pests, diseases and other climatic conditions (Khan, 1995). Greenhouses are structures suitable for protected cultivation, which protects the plants from wind, precipitation, excessive radiation, temperature extremes, insects and diseases (Attavar, 1993).

Cooling is considered as the basic necessity for greenhouse crop production in tropical and subtropical regions to overcome the problems of high temperatures during summer months. Development of suitable cooling system that provides congenial microclimate for crop growth is a difficult task as the design is closely related to the local environmental conditions. Broadly there are two types of cooling systems namely natural ventilation and evaporative cooling.

Natural ventilation is the direct result of pressure differences created and maintained by wind or temperature gradients. It requires less energy and equipment and is the cheapest method of cooling a greenhouse. It depends heavily on evapo-transpiration cooling provided by the crop.

Evaporative cooling is the most effective cooling method for controlling the temperature and humidity inside a greenhouse. However, its suitability is restricted to the respective region and climate. It can be provided by fixing either one of the following: fan and pad system, fog/mist system and roof evaporative cooling. Fan and pad greenhouse air temperature will be always lower than greenhouse with natural ventilation (Teitel *et al.*, 2008).

Kumar *et al.* (2009) reviewed the greenhouse cooling technology and design for tropical and subtropical regions. The study revealed that a naturally ventilated greenhouse with larger ventilation areas (15-30 %), provided at the ridge and sides covered with insect-proof nets of 20-40 mesh size with covering material properties of NIR (near infrared radiation) reflection during the day and FIR (far infrared radiation) reflection during night is suitable for greenhouse production throughout year in tropical and subtropical regions.

Greenhouse performance of six potted anthurium cultivars in a subtropical area was carried by Wang (1999). Based on the study, growing anthurium cultivars at maximum 30°C air temperatures is recommended for good quality and high flower count.

Naturally ventilated greenhouses were found to provide a favourable environment for gerbera by Biradar *et al.* (1997) and ICAR (1999). Very high yield of 200 to 250 flowers per sq. m. per year was observed under green house in comparison to a low yield of 120 to 150 flowers per sq. m. per year under open (Das and Singh, 1999). More than 85 per cent of flowers produced under greenhouse were of best quality. Gajanana *et al.* (2003) conducted a study in nine gerbera varieties in two types of polyhouses namely, naturally ventilated polyhouse (NVPH) and Fan and Pad Greenhouse (FPGH) of uniform size (12 m × 30 m) and recorded data on cost of establishment, cost of cultivation, yield and price realized for different grades of flowers were recorded.

In humid tropical climates, the effect of screen mesh size on microclimate, vertical temperature distribution and air exchange rates in naturally ventilated greenhouse was reported by Soni *et al.* (2005) and Harmanto *et al.* (2006). The highest temperature value was obtained at the points near to the roof which was about 5°C higher than the coolest point in the vertical direction. The lowest 60 per cent of the height profile registered only 86-92 per cent of the maximum temperature value, while the upper 40 per cent registered 92-100 per cent. A decrease in porosity increased the vertical gradients from 5 to 10 per cent.

Fuchs *et al.* (2006) developed a procedure to evaluate the latent heat cooling by means of crop transpiration and free water evaporation from wet fan and pad system. They found that covering material property of 30 per cent reduced solar radiation transmission at ventilation rate of 30 volume exchanges per hour maintained the temperature of greenhouse with in safe limits for growing rose crop during summer.

2.5. Growing Environment of foliage plants

Microclimate is the key factor deciding the growth of any plant. Growth and quality of foliage plants depend on the interactions between environmental factors and genetic constitution of the plant. Factors like temperature, light intensity and humidity can limit the quality of foliage of the plants including colour, size, shape etc (Swapna, 1996).

2.5.1. Temperature

Temperature requirements of foliage plants have to be evaluated as to accommodate the plants in different types and locations of indoors from air conditioned office space to machineries filled workplace. Temperatures affect growth rate of foliage plants as much as any other factor by influencing rates of photosynthesis and respiration (Went, 1953; Gates, 1968; Hadfield, 1968). Most indoor plants are tropical in nature, and require a minimum night temperature of 18 °C and day temperature of 24 °C (Bose and Chowdhury, 1991). Naqvi (1999) reported 20-30°C as the most ideal range of temperature for cut foliage production.

Conover and Poole (1981) stated that the research information is available on day/ night temperature differentials for roses, chrysanthemum, and other horticultural crops, but is very limited on foliage plants. Some benefits can be obtained with differences in day and night temperatures of 2.7° to 5.5°C. Night temperatures below 18.3°C can seriously reduce growth of many tropical and subtropical foliage plants, especially *Aglaonema*, *Dieffenbachia*, and *Epipremnum*, but *Hedera*, *Ardisia*, *Podocarpus*, *Pittosporum*, and other temperate foliage plant genera can tolerate lower temperatures without serious loss in growth or quality. Manaker (1997) also mentioned that there is no specific temperature at which all plants grow best, but rather an optimal range of temperature is there for each plant species. For most tropical foliage plants, a temperature range of 18 to 24 °C is satisfactory.

In a trial with *Impatiens wallerana* var. Petersiana, Zimmer (1980) observed that a temperature in the range of 14 to 18 °C and 16 hrs at 16 klx gave the best foliage colour, while 26 °C and 16 hrs at 6 klx produced the greatest number of leaves. Flower bud formation was the greatest at 18°C and 16 hrs at 6 klx.

Poole and Conover (1981) reported that temperature as high as 38 °C and 44 °C reduced the quality of *Calathea makoyana, Chamaedorea elegans, Dieffenbachia maculata* 'Perfection' and *Nephrolepis exaltata* 'Bostoniensis'. Chase and Poole (1987) reported optimum shoot growth of *Syngonium podophyllum* 'White Butterfly' at a maximum air temperature between 32°C and 41°C during summer and a minimum air temperature of 18.5°C and 21°C during winter.

Mortensen (1991) reported an increase in dry weight and number of leaves of *Dieffenbachia maculata, Nephrolepis exaltata* and *Syngonium podophyllum* with the mean maximum day temperature of 30-32°C. He classified about 9 species of foliage plants as having high temperature requirement with an optimal temperature of 24-27°C. Bench heating with a root-zone temperature of 30 °C and an air temperature among the plants of 23-24°C reduced the cultivation time for *Schefflera arboricola* 'Compacta' and *Ficus benjamina* by 2.5 weeks compared with the lowest temperature of 19°C, without affecting the ornamental value (Vogelezang, 1991).

The growth of two *Spathiphyllum* cultivars, 'Petite' and 'Tasson' under three different temperature regimes, 29, 35 and 41 °C for 12 hours daily, and night temperatures of 21 °C for 12 weeks was studied by McConnell *et al.* (2003). They observed that the two cultivars developed narrower leaves at temperatures above 29 °C, and growth rates decreased with each 6 °C rise in temperature. Additionally, they also studied the growth responses of eight *Spathiphyllum* cultivars to a 1.5-hour exposure to temperatures of 40, 45, and 50 °C and revealed that growth indices significantly decreased at 45 °C with the exception of two cultivars, 'UF474-1' and 'UF576-14', whose growth was unaffected, suggesting that genetic variation to heat tolerance exists among cultivars.

Based on the evaluation study, Chen *et al.* (2005a) recommended that fire flash (*Chlorophytum amaniense*) can be produced as a potted foliage plant under light levels from 114 to 228 $\mu mol.m^{-2}.s^{-1}$ and temperatures from 18 to 32 °C. Biondo and Noland (2006) also recommended a temperature range of 65 to 80 °F during night and 75 to 95 °F during day for foliage plants.

Lopez *et al.* (2009) evaluated propagation and production of *Zamioculcas zamiifolia* in a greenhouse and suggested that commercial propagation and production time of *Zamioculcas* can be reduced by propagating apical leaflet cuttings under a 16-h photoperiod and a photosynthetic day light integral (DLI) as low as 0.6 mol $m^{-2}d^{-1}$ and by subsequently growing plants at 29 to 32°C.

2.5.2. Relative Humidity

Relative Humidity is one of the main environmental factors to be considered in the greenhouse as it has more influence on plant-water relations, greenhouse cooling and pest and disease incidences.

Commercial growers generally maintain relative humidity levels of 50 percent or more in greenhouses as a requirement for foliage plant growth (Conover and Poole, 1981).

A trial on twenty-two species of foliage plants at 60 and 80 per cent RH (constant temperature of 24 °C, either in natural light or supplementary lighting) conducted by Mortensen *et al.* (1988) showed an increase in dry weight for three species, straggly growth in 5 species and paler leaf in 9 species with increased relative humidity. In another study on the effect of RH in 23 ornamental foliage species, (Mortensen and Gislerod, 1990) an increase in relative humidity from 60 per cent to 85 per cent significantly increased the dry weight and plant height.

Most of the plants used in interior landscapes have been produced in an environment where the relative humidity ranged from 85 to 95 per cent. This is far in excess of the 40 per cent or lower relative humidity of many building interiors. Although most tropical foliage plants thrive at humidities greater than 30 per cent, they will survive in the low-moisture environments of building interiors if they are properly acclimatized (Manaker, 1997).

Naqvi (1999) stated that for foliage plant production, the humidity level should be maintained between 60 and 70 per cent and humidity beyond this limit will invite leaf diseases as well as increase the susceptibility of plants to diseases.

2.5.3. Light requirement

By evaluating the foliage plants for their light requirements and adaptability to various light conditions, proper arrangements can be done in the indoor either by placing the plant in an appropriate area of a house or by providing supplementary artificial light. Bose and Chowdhury (1991) stated that supplementary lighting may be provided to enhance the growth of foliage plants.

Crocker (1949) stated that light quality and not the intensity decided the morphological characters of plants. However according to Thompson and Miller (1963) light intensity had the influence on cell enlargement and differentiation and thus influenced height, growth, leaf size and the structure of leaves and stems of plants.

Gastra (1963) found a linear relationship between photosynthesis and light intensity at low levels. Allamand (1971) suggested that in crotons the leaf anthocyanin content was found to be the highest between 2900 and 4300 lux.

Conover and Poole (1975) recorded chlorophyll levels of 0.055 mg/cm^2 in leaves of sun grown *Dracaena marginata* and 0.081 and 0.100 mg/cm^2, respectively, in those grown under 40 and 80 per cent shade for 6 months. Ross (1976) also proved the effects of light intensity on plant growth. He found that the plants grown in full sun appeared stunted with stiff branches and sparse foliage. But they were tall and lanky with abundant foliage as shade increased. Leaves developed under 80 per cent shade were larger than those in full sun. Such leaves had more surface area exposed and thus, more opportunity to use low light. Chlorophyll content on a leaf basis increased from full sun to 80 per cent shade.

According to Milks (1977) chlorophyll content increased in plants kept under low-light interior environment, but was the greatest in plants grown under 63 per cent shade, increasing from 0.027 to 0.081 mg/cm^2. It was observed by Priessel *et al.* (1980) that *Codiaeum variegatum* var. Pictum showed reduced chlorophyll and carotenoid contents with increased light intensity. Many tropical foliage plants have low light intensity requirements in their native habitats (Smith and Scarborough, 1981).

Hoflacher and Bauer (1982) reported increased photosynthetic rates in the leaves of *Hedera helix*, under high light intensities. Shen and Seely (1983) reported that in *Peperomia obtusifolia* reducing the light intensity decreased the fresh and dry weight of plants but did not affect the leaf nutrient content.

An investigation was carried out to study the effect of various light intensities on the growth and development of indoor foliage and flowering plants such as *Aglaonema, Aralia, Alocasia, Chlorophytum, Coleus, Cordyline, Dieffenbachia, Dracaena, Maranta, Peperomia, Pleomele, Rhoeo, Balsam, Begonia* and *Verbena*. The treatments consist of full sunlight, 75, 50, 25 and 10 per cent light. The results showed that with decrease in light intensities, plant height was increased in most of the plants. It also enhanced leaf production, leaf area and chlorophyll content. High light intensities enhanced flowering in balsam, begonia and verbena. In balsam greater anthocyanin content was associated with diminishing light intensities (Aasha, 1986).

Aglaonema costatum, Philodendron erubescens and *Chlorophytum comosum* responded best to light intensity of 4000-5000 lux with respect to height of plants, number of leaves and size of leaves (Sharma *et al.*, 1992). A best quality plant of Dieffenbachia 'Star White' was produced at lower irradiance of 200-500 μ mol m^{-2} (Henny *et al.* 1992).

Bromeliads with thick, hard, grey or fuzzy foliage withstand the highest light intensities while those with soft, green thin leaves grow best under low light intensities (Black and Dehjan, 2003). They usually require 12 to 16 hrs of relatively bright light daily. More compact growth and better leaf and inflorescence colour are obtained at 3000-4000 foot candle (Plever, 2006). Light requirements of most foliage plants fall between 1500 and 8000 foot candles (Bionda and Noland, 2006). Hazmin (2007) evaluated nine species of bromeliads and six species of ornamental bananas for their suitability to tropical landscapes, interior plantscapes by growing them under open and 50 per cent shade levels and she found significant difference in their growth pattern and recommended suitable species for tropical landscapes and interior plantscapes.

Anthuriums grow under a wide range of light intensities but actual performance depends on the cultivars, elevation, temperature and nutrition. Generally most of the anthurium types grow well at light intensities ranging from 11,000 to 16,000 lux. Light intensities higher than 27,000 lux may result in faded flower colour and leaf colour (Gayathri, 2008). Femina (2006) also tested four cut flower varieties of Anthurium under different growing structures with different cladding material and shade nets of different percentage and found significant difference in growth and flowering behaviour among the varieties.

Whiting *et al.* (2010) when commenting about light quality to indoor plants mentioned that blue light is primarily responsible for vegetative leaf growth and red light, when combined with blue light, encourages flowering. They recommended fluorescent cool white lamps which are high in the blue range, and the best choice for starting seeds indoors, whereas for flowering plants needs more red light, so use broad spectrum fluorescent bulbs.

Based on the study using 27, 43, 57 or 73 per cent shade on Anthurium, Poole and McConnel (1971) opined that decrease in shade level did not affect flower production but reduced flower stem length. Leaves of plants kept under 27 per cent shade became chlorotic. Svenson *et al.* (1991) reported that *Schefflera actinophylla* cv. Amate had produced a uniform growth habit even under retractable shading. The total stem fresh weight of *Ruscus hypophyllum* under 50 per cent shade was increased by 14 per cent compared to plants grown under 70 per cent shade (Stamps and Boone, 1992).

Swapna (1996) studied the environmental effects on the growth of *Philodendron wendlandii* and concluded that 50 per cent shade produced good quality plants. The excellent ability of most of the foliage plants to adapt to low light intensities have enabled their use for interior decoration. Studies in Kerala Agricultural University have shown that foliage plants grown under 50 per cent shade were superior in terms of growth, visual appearance and plant quality rating (Geetha *et al.*, 2002).

Vladimirova *et al.* (1997) conducted a trial to study the response of *Dracaena sanderiana* 'Ribbon' to different shade levels viz., 47, 63, 80 and 91 per cent and observed varied response by the plants for each shade levels. Plants grown in 47 and 63 per cent shade were less variegated than those in 80 per cent or 91 per cent shade whereas 91 per cent shade showed the maximum leaf variegation. More leaves with less leaf area, larger internodes and larger root mass developed in plants grown under 63 per cent shade, whereas under 80 per cent shade they were just opposite. Faster growth with greater biomass was correlated with 63 and 80 per cent shade than in 47 and 91 per cent shade.

An evaluation study conducted at National Crop Research and Development center, Philippines, revealed that *Dracaena marginata, Pleomele reflexa* and *Murraya paniculata* responded well in the open field, whereas partial shade condition was preferred by *Microsorium punctatum, Dracaena sanderiana* and *Dracaena godseffiana* (Nicdao and Gabertan, 2002).

2.5.4. Pest and Disease incidence

Hamlen *et al.* (1981) reported some of the common sucking pests like aphids, whiteflies, mealy bugs, scales and thrips along with lepidopterous larvae and nematodes as economically important ones in foliage plant production.

Manaker (1997) reported that numerous pests are known to attack foliage plant indoors. Some of the important pests types attacking foliage plants in indoor are aphids, mealy bugs, red spider mites, scale, whiteflies, slugs, cyclamen and broad mites, thrips, fungus gnats, root mealy bugs and nematodes. He also reported common symptoms of diseased plants include stunting, chlorosis, leaf spots, leaf scorch, leaf abscission, and rotting of the roots and stems. He further insisted that even a disease is diagnosed and controlled, disease-damaged foliage will never return to normal.

Chase (1993) reported four major diseases caused by *Colletotrichum, Cylindrocladium*, *Pythium* and *Rhizoctonia* on leather leaf fern. A new collar rot and foliar blight disease caused by *Fusarium subglutinans* on *Aglaonema commutatum* was reported by Uchida and Aragaki (1994) in Hawaii, USA.

Martini *et al.* (2000) reported new fungal diseases caused by *Cylindrocarpon* sp., *Fusarium* sp., *Rhizoctonia* sp. and *Macrophomina* sp. on various foliage plant species. Pasini *et al.* (2001) reported *Fusarium oxysporum* to be pathogenic on *Ruscus* and on other ornamentals like *Asparagus plumosus* and *Asparagus densiflorus.* Stamps (2002) reported Florida fern caterpillar, leatherleaf fern borer and leafhoppers as potential pests in leatherleaf fern production. He also reported major foliar diseases caused by *Cylindrocladium* sp. and *Rhizoctonia* sp. on the plant.

2.6. Role of foliage plants in interior plantscaping

Several studies were conducted on the use of ornamental plants for interiorscaping all over the world (Russ and Pertuit, 2001; Stamps, 2002).

Foliage plants are used as living adornments for interior decoration. Plants from the world's tropical or subtropical regions provide the basis for today's foliage plant industry. The industry has been enjoying steady growth with a wholesale value of $574 billion in 2000 (Chen *et al.*, 2001).

Low light is the most important factor influencing the performance of foliage plants under interior conditions (Chen *et al.*, 2005). A distinct characteristic of many foliage plants is their ability to tolerate low light levels. Foliage plants have been predominantly cultivated in shaded greenhouses. Finished plants can be directly placed in interiorscapes if produced under an appropriate light intensity or they must be acclimatized during the final production process (Conover and Poole, 1984; Chen *et al.*, 2001). Acclimatization is a serialized process of adapting the plants to interior conditions.

Conover and Poole (1981a) found that flowering of *Saintpaulia ionantha* (cv. Lnge) ceased when the plants were transferred to interior light levels of 0.5, 1 or 2 klx from a green house at 13 klx. Plants placed under 2 klx flowered after 3 months while plants under 1 klx flowered after 6 months. Only minimal flowering occurred at 0.5 klx after nine months.

Conover and Poole (1989) conducted an experiment to study the effects of fertilizer and irrigation levels on the maintenance of *Ficus benjamina* and *Ficus retusa* 'Nitida' in an interior environment. They observed that the plant grade of F. *benjamina* was better without addition of fertilizer while F. *retusa* 'Nitida' was best at the middle fertilizer level and the electrical conductivity of leachate was highly correlated with fertilization.

Performance evaluation of 21 anthurium cultivars for interior use was done by Henley and Robinson (1994). From the study, it was observed that light levels and nutrition affect leaf size and number, colour retention and general plant quality.

Reyes *et al.* (1996) tested the light acclimatization potential of *Chrysalidocarpus lutescens* Wendl. by placing the plants indoors with conditions of 20 micromole.$m^{-2}.s^{-1}$ for 12 hrs daily at 21 ±1°C and a relative humidity of 50 ± 5 per cent for 3 months. After the period, he observed that there is 45 to 55 per cent reduction in soluble sugar concentrations in leaf, stem, and root. Starch concentrations in stem and root decreased by 97, 62 and 72 per cent respectively, compared to the concentration when they were kept outdoors. Light Compensation point (LCP) also declined. From this, he inferred that the depletion in drastic carbohydrate concentration during the interior holding period indicates the C. *lutescens* is not a species good for extended use under very low interior light conditions.

Davison (1998) stated that artificial light can be used to supplement or replace natural sunlight to indoor plants. Cool white fluorescent lights alone or in combination with warm light fluorescent lights are the most economical and best all-purpose lamps. Typically, a fixture holding two 40-watt tubes is positioned approximately 12 inches above the plants. Most plants need 12-16 hours of artificial light per day for good growth. For large specimen plants, use spot or flood lights to maintain good appearance and accent of the plant.

Anthurium can grow and flower under low light conditions; thus it is becoming more widely used for interior plantscaping (Griffith, 1998). Five Anthurium cultivars were evaluated in interior rooms under two light intensities: 16 μ mol m^{-2} s^{-1} (100 foot candle as low light) and 48 μ mol m^{-2} s^{-1} (300 foot candle as high light) for five months. The results showed that plant quality of both conditions were remained excellent, leaves were dark green and shiny; flowers were colourful and long lasting, suggesting that potted Anthurium is a true interior flowering foliage plant. Some cultivars are able to grow and flower continuously under interior conditions for three years (Chen *et al.*, 1999).

Chen *et al.* (2005a) evaluated the performance of fire flash (*Chlorophytum amaniense*) in building interiors and found that the plants were able to maintain their aesthetic appearance under a light level as low as 8 $\mu mol.m^{-2}.s^{-1}$ for 8 months or longer. Chen *et al.* (2005) investigated the adaptability of foliage plants with respect to interior low light conditions. They had evaluated three species viz., *Ficus benjamina* 'Common', *Dieffenbachia maculata* 'Camille', and Anthurium variety Red Hot. All the three showed great adaptability either by increasing or decreasing their physiological/biochemical activities.

The effect of shading levels and their duration on the quality and performance of weeping fig and garden croton in a simulated interior environment was investigated under 50, 70 and 90 per cent shading for three months. After this period, half of the plants belonging to 50 and 70 per cent shading levels were transferred to 90 per cent shade for two months. At the end, plants were transferred to a characteristic interior environment (low light and RH) and kept for eight weeks. From the result, it was found that weeping fig showed better adaptation to interior conditions if the plants were transferred to the highest shading level only during the last period of production. In contrast, garden croton grown under low light intensity during all or a part of the cycle had higher aesthetic characteristics values during indoor life (Scuderi *et al.*, 2010).

The photosynthetic light-response curves of *Aglaonema commutatum* 'Silver Queen', *Anthurium andreanum* 'Dakota' , *Dieffenbachia picta* 'Camilla', *Philodendron erubescens* 'Red Emerald', *Spathiphyllum wallisii* 'Mauna Loa', and *Syngonium podophyllum* 'Maya Red' were analyzed after a three-month acclimatization period in a phytotron under 380-400 ppm CO_2 concentration, 26 ±2 °C temperature and 8/16 hours of light/night (20 $\mu molm^{-2}s^{-1}$ neon lamps) by Giorgioni and Neretti (2010). After the acclimatization period, Light compensation point (Lc) was lower than 9 $\mu molm^{-2}s^{-1}$ photosynthetic photon flux density (PPFD) for all species and both CO_2 concentrations while respiration (Rd) was between -1.2 and -0.1, with significantly higher values at 800 ppm CO_2 only in *Aglaonema*, *Dieffenbachia* and *Spathiphyllum*. At PPFD of 200 $\mu molm^{-2}s^{-1}$, CO_2 enrichment increased assimilation from 34.7 (*Philodendron erumbescens*) to 93.1 per cent (*Syngonium*), reaching 1.42 in *Philodendron erumbescens* and 6.26 $\mu mol\ CO_2 \times m^{-2}s^{-1}$ in *Philodendron pertusum*. The high apparent quantum efficiency (AQE) values in *Philodendron pertusum*, *Philodendron erubescens*, *Syngonium* and *Dieffenbachia* demonstrate the relatively higher capacity of the four Araceas to promptly react to increased light and sun flecks, when grown under a low photon flux density.

2.6.1. Beneficial effects of foliage plants

Many of the research studies documenting the beneficial effects of plants on people have focused on plants outdoors or on scenes of nature. Research has shown that interior plants in individual containers can also produce the same benefits. Research has confirmed the stress-reducing benefits of passively viewing plants. It has demonstrated that people's impressions of a room and their mental well-being can be significantly improved when plants are added. It also has shown that productivity and mental functioning are improved and that pain perception can be reduced. Research on the effects of plants on people has shown, in essence, that plants are essential for people to be at their best. Plants are needed in our lives, all around us, everyday. They have a civilizing effect; they humanize our surrounding (Lohr, 2010).

The studies showed that many common foliage plants reduced levels of some interior pollutants, including formaldehyde and carbon monoxide, from small, sealed test chambers (Wolverton *et al.*, 1984;1985; Zhou, 2011). The pollution reduction was largely due to bacteria growing on the plant roots (Wolverton *et al.*, 1989; Wood *et al.*, 2002). Further research has shown that plants remove many indoor air pollutants, including ozone, toluene, and benzene (Darlington *et al.*, 2001; Wood *et al.*, 2002; Papinchak *et al.*, 2009).

One study documented that foliage plants can raise relative humidity to healthier and more comfortable levels in interior space (Lohr, 1992). In this study, when plants were present, less than 2 % of the space was occupied by the plants, yet relative humidity was raised from 25 per cent without plants to 30 per cent with plants.

The influence of interior plants on dust accumulation has also been explored (Lohr and Pearson-Mims, 1996). Freeman (2003) reported that plants can reflect, diffract, or absorb sounds, depending on the frequency. Plants were shown to reduce noise under certain conditions.

Aglaonema treubii is a valuable source for glycosidase inhibitors that are antidiabetic, antimetastatic, antiviral, and immunomodulatory agents. In particular, α-glucosidase inhibitors such as α-homonojirimycin and β-homonojirimycin isolated from *Aglaonema treubii* have been shown to be potentially therapeutic agents for diabetes type 2 and HIV-1 infection. A new indole alkaloid, decursivine, isolated from *Rhaphidophora decursiva*, exhibits antimalarial activity. The powder of *Homalomena aromatica* rhizomes is used as an anti-inflammatory agent, a tonic for treatment of skin disease in India. Recent studies showed that linalool, a volatile oil isolated form the rhizome of *Homalomena* had activity against *Curvularia pallescens*, *Aspergillus niger* and *Fusarium graminearum* (Chen *et al.*, 2007).

Thomas and Müller (2010) conducted a pilot study on people-plant relationships in indoor work environment and they concluded that plants and flowers at least to some extent belong in the indoor work environment. Dumitras *et al.* (2010) has recommended 26 m^2 of green spaces/inhabitant in urban areas to cope with various kinds of pollution and suggested methods involving vegetation in the vertical arrangements in walls of buildings.

Studies revealed that presence of plants in schools provide an aesthetic environment in which students live in and creates an educational environment that offers teachers the opportunity to teach various subjects and enhance environmental awareness of students. They also highlighted that environmentally based education programs can have a positive effect on student performance in addition to attention and enthusiasm for learning (Akoumianaki-Ioannidou *et al.*, 2010).

2.7. Air pollution Tolerance Index (APTI)

In the last decade, India witnessed rapid growth of industrialization which lead to unplanned expansion of urban areas by large scale felling of trees. Rapid migration and increase in population also lead to large scale spreading of air and water pollution, garbage etc., and also impairing aesthetic value of land. In response, urban greening has to be promoted to maintain the social and natural sustainability in cities by increasing vegetated surface in urban landscape in outdoors (Joshi and Gautam, 2010). The studies showed that many common foliage plants reduced levels of some interior pollutants, including formaldehyde and carbon monoxide, from small, sealed test chambers (Wolverton *et al.*, 1984;1985). Indoors also has to be spaced for plants based on their tolerance and susceptibility to various pollutions. Thus by adding vegetation in urban areas and also by providing ecological diversity, we can mitigate several negative effects of urbanization physically and psychologically, especially, the air pollution and its effects.

Different plant species vary considerably in their susceptibility to air pollutants. The identification and categorization of plants into sensitive and tolerant groups is important because the former can serve as indicators and the latter as sinks for the abatement of air pollution in the indoors and proper care can be provided to those sensitive plants from the effect of pollution. To screen plants for their sensitivity/tolerance level to air pollutants, a proper selection of plant characteristics is of vital importance. Singh and Rao (1983) has computed a formula to obtain an empirical value signifying the Air Pollution Tolerance Index (APTI) of species using four parameters namely ascorbic acid, total chlorophyll content, relative water content and leaf extract pH.

With the APTI values, Singh *et al.* (1991) evaluated 69 plant species, including herbs, shrubs and trees and categorised them into sensitive, intermediate, moderately tolerant and tolerant classes.

Wood and Burchett (1995) emphasized the application of APTI estimation in interior foliage plants, as it can be used to assist in the routine maintenance and management of indoor plants, and in the concomitant quality of the indoor air for the occupants of the building.

On the basis of APTI and some relevant biological and socio-economic characteristics, the anticipated performance of 30 plant species in a Green Belt plantation at Kolkata and Howrah was calculated. Plant categories were graded as best, excellent, good, moderate and poor. Species belonging to the first four categories were recommended (Shannigrahi *et al.*, 2004).

Karthiyayini *et al.* (2005) evaluated 27 species of trees, shrubs, herbs and climbers which are growing in Coimbatore-Ooty highway. They found that *Azadirachta indica*, amongst trees, *Ricinus communis*, *Bougainvillea spectabilis* and *Calotropis gigantea*, amongst shrubs, *Amaranthus viridis* and *Datura stramonium* amongst herbs *Cucurbita pepo* amongst climbers showed high degree of tolerance and they recommended them as bio-indicators as well as bio-accumulators for the air pollution along roadsides.

Investigation done in plants growing along the roadside of Vishrambag and Shashtri Chowk, Sangli city for APTI showed that plants were affected by increased atmospheric pollution and it was found that plants can be used as bio-indicators to assess the accumulation of autoexhaust pollutants like SO_2, NO_2 and particulate matter (Gaikwad *et al.*, 2006). In the same way, Chauhan (2010) also evaluated some tree species grown in Dehradun city to test the effect of automobile pollution on plants and found pollutants emitted from automobiles adversely affecting the ambient air and tree pigments and thus creating adverse impacts on human health. He emphasized the use of trees as bio-indicators for such pollution.

Sulistijorini *et al.* (2008) examined the combination of the relative growth rate (RGR) and physiological responses (APTI) in determining tolerance levels of plant species to air pollutants. Among the eight roadside tree species tested, *Lagerstroemia speciosa* was categorised as a tolerant species and *Pterocarpus indicus, Delonix regia, Swietenia microphylla* as moderately tolerant and *Gmelina arborea, Cinnamomum burmanii* and *Mimusops elangi* as intermediate tolerant species. They concluded that the combination of RGR and APTI values would be better to determine tolerance level of plant to air pollutant than merely APTI method.

Liu and Ding (2008) have collected 23 plant species growing near a Beijing steel factory and estimated their APTI values. From the results, they highlighted the need for APTI measurements to be conducted throughout the growing season, when evaluating pollution tolerance of individual species and they stressed that the APTI of species was indicated as an ideal candidate for landscape planting in the vicinity of polluting industry.

Lakshmi *et al.* (2008) estimated the APTI values of tree species grown in industrial area of Visakhapatnam city and found that among 24 species tested, 20 were having low values of APTI and remaining species identified as moderately tolerant. Thus they suggested that estimation of APTI values help to identify tolerant species to air pollution and which may further help in proper selection of species in urban plantation programme. Singh (1993) also suggested that the APTI can be used as a good indicator of the impact of pollution on plants.

In Moradabad city, Tripathi *et al.* (2009) evaluated ten different plant species from residential, industrial and commercial area for their APTI values. They found that as the city meant for Brass and allied industries, they are the prominent sources responsible for the elevated level of air pollutants at the industrial site. Highly significant results were obtained by them in industrial site. They proposed that by analysing such parameters would be useful for the better understanding and management of air quality as well as in selection of suitable plant species for plantation in industrial areas as well as roadside and this may become main strategy for the abatement of city's air pollution.

With a view to find out the air pollution tolerance as well as sensitivity of the plant species growing adjacent to NH-47 passing through Thiruvananthapuram during different seasons, an evaluation study was carried out by Jyothi and Jaya (2010). The study identified different species of trees and shrubs tolerant and sensitive to air pollutants as bio-accumulator and bio-indicator respectively to be planted along the highways. Likewise, in Kothagiri municipal town-the Nilgiris, 24 tree species were analyzed and six species were identified as tolerant among them with high APTI values. (Senthilkumar and Paulsamy, 2011; Begum and Harikrishna, 2010); Chandawat *et al.* (2011) in South Bengaluru and Ahmedabad respectively.

Mondal *et al.* (2011) also evaluated ten tree species of Burdwan town, West Bengal by Anticipated Performance Index (API) using APTI values together with other socio-economic and biological parameters and recommended tolerant species for green belt development.

2.8. Microbes

As bio-aerosols, a major ingredient of indoor air pollution, containing air borne micro-organisms and their by-products which has potential to cause respiratory disorders and other adverse health effects to man such as infections, hypersensitivity pneumonitis and toxic reactions (Fracchia *et al.*, 2006). Microbes can enter indoor areas either by means of passive ventilation or by means of ventilation systems. Many genera of bacteria and fungi are also emitted by indoor sources like animals, flowerpots and wastebaskets (Yassin and Almouqatea, 2010).

Wolverton and Wolverton (1996) through their experiment, proved that house plants are influencing the level of microbes in air where large numbers of plants are grown. They further found that despite of high humidity levels in the plants filled room than plant-free room, air borne microbial levels were more than fifty per cent higher in the plant-free room.

Yassin and Almouqatea (2010) assessed airborne indoor and outdoor bacteria and fungi using the ‘open plate technique’ to investigate the enumeration and identification of airborne micro-organisms. They could detect 26 groups of bacteria and fungi, either of human or environmental origin. In particular, seven genera of fungi, mainly members of the genus *Aspergillus,* were isolated from all residents and they reported that bacteria showed higher growth numbers compared to the slow growing fungi.

2.9. Dust filtering efficiency of indoor plants

Kalam and Singh (2011) defines Indoor Air Pollution (IAP) as pollutants found indoors, generally due to inefficient fuel consumption, chemical pollution to building materials, and so on. Dust particles form a major part of the air pollutants arising due to industrial process and pose serious threat to the ecosystem. Urban Outdoor Pollution contributes to Indoor Air Pollution. Dust has been known to travel several thousands of miles, across deserts and seas. Most cities in the world have exceeded the air quality guidelines with a world average of 71 micrograms per cubic meter. In India 35-45 % of air pollutants comprises of dust particles (Nayak *et al.*, 2008). WHO estimates that two million people die every year due to inhalation of tiny particles in air pollution causing health hazards such as heart disease, lung cancer and asthma, the most common victims being women, and children under the age five (Anon, 2011a). Recently, Hantavirus, a disease spreading to human beings from rodents that have symptoms similar to influenza is reported that man can get infected by this disease if they come in contact with dust contaminated with mice droppings; during dusting or cleaning and casualties have been reported in India too (Anon, 2011b).

Vijay (2010) reported that plants act as barriers for the movement of pollutants, thus by filtering out the pollen and mould spores from the air. He also pointed out that the amount of dust reaching the ground after filtering by a canopy of trees is about 27-42 per cent less than open area. Plants, by offering physical obstruction, separate the suspended particles of the air like a sieve (Das *et al.*, 1981).

As discussed by Beckett *et al.* (1998), plants provide many beneficial characteristics that enable them to capture pollutant particles and hence reduce their concentration in air. As Indoor Air Pollution is concerned, the presence of interior plants can alter the characteristics of indoor air.

Lohr and Pearson-Mims (1996) found that the presence of foliage plants in the indoor lowered particulate matter accumulation and they also reported that relative humidity was higher when plants were present. They documented that the accumulation of particulate matter on horizontal surfaces in interiors can be reduced by as much as 20 per cent by keeping foliage plants.

Beckett *et al.* (2000) conducted study to identify trees from five contrasting species that maximize the benefit to local air quality and found that all trees captured large quantities of airborne particulates.

Kulshreshtha *et al.* (2009) has investigated particulate pollution mitigating ability of some plant species like *Bougainvillea, Terminalia arjuna, Cassia fistula* and *Polyalthia longifolia* by analysing characters such as cuticle injury, changes in epidermal cell, stomata size and frequency and found that *Bougainvillea* showed no visual symptoms even with more dust load.

Materials and Methods

3. MATERIALS AND METHODS

The investigation entitled "Evaluation of foliage plants for interior plantscaping" was conducted at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, Thrissur during 2011-12. The materials used and the methodology adopted for the investigation are presented in this chapter.

3.1. Location

Geographically the area is situated at a latitude of 10°31`N and longitude of 76°13`E. The area lies 22-25m above the mean sea level.

3.2. Climate

The climate is humid tropical. The weather parameters recorded during the period of observation are presented in Appendix 3.

3.3. Evaluation of foliage plant species under two growing systems

3.3.1. Materials

Fifty species of foliage plants, representing a wide spectrum of morphological variability were selected for the study. List of plant species selected with their common names and family are given in Table 1.

3.3.2. Growing systems

The selected foliage plant species were evaluated under two growing structures *viz.*, open ventilated rain shelter (OV) and Fan and Pad greenhouse (FP), both with 50 per cent shade.

3.3.3. Planting and general management

Planting was done in pots of 30 cm diameter. Sand, well rotten FYM, and red earth in 1:1:1 ratio was used as the medium. Six months old uniform sized plants were selected for the study. Uniform management practices were adopted for all the species in both the structures. In the rain shelter, plants were irrigated once a day and in the pad & fan system misting was provided periodically to maintain the relative humidity. Need based application of plant protection chemicals was also done.

Plate 1a. General view of open ventilated structure (OV)

Plate 1b. Foliage plants grown inside open ventilated growing system

Plate 2a. General view of fan and pad system (FP)

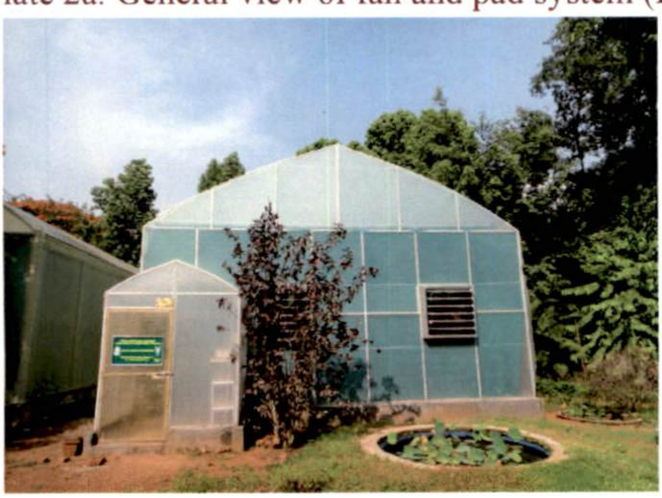


Plate 2b. Foliage plants grown inside fan and pad system

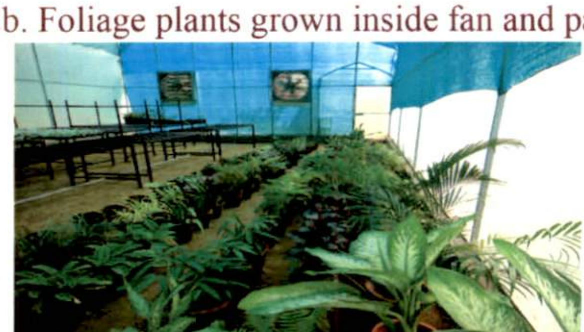


Table 1. List of plants selected for the study

S. No.	Scientific name	Common name	Family
1.	*Aglaonema nitidum* 'Curtisii'	Chinese evergreen	Araceae
2.	*Aglaonema pseudobracteatum*	Golden Evergreen	Araceae
3.	*Alpinia zerumbet* 'Variegata' Syn: *A.nutans, A.speciosa*	Variegated shell ginger, Variegated shell flower	Zingiberaceae
4.	*Anthurium andreanum* 'Bonina'	Anthurium	Araceae
5.	*Anthurium crystallinum*	Flamingo flower	Araceae
6.	*Asparagus setaceus* Syn: *A. plumosus* Baker	Fern asparagus, Lace fern, Climbing asparagus	Liliaceae
7.	*Begonia rex*	Rex Begonia	Begoniaceae
8.	*Calathea ornata* 'Roseo-lineata'	Prayer plant	Marantaceae
9.	*Calathea zebrine*	Zebra plant	Marantaceae
10.	*Chlorophytum* 'Charlotte'	Spider plant	Liliaceae
11.	*Chrysalidocarpus lutescens* Syn: *Areca lutescens*	Areca palm	Arecaceae
12.	*Chrysothemis pulchella*	Sunset Bells, Black Flemingo, copper leaf	Gesneriaceae
13.	*Codiaeum variegatum* 'Delaware'	Croton	Euphorbiaceae
14.	*Codiaeum variegatum* 'Punctatum aureum'	Croton	Euphorbiaceae
15.	*Costus curvibracteatus*	Spiral Ginger, Orange tulip ginger	Costaceae
16.	*Cyperus alternifolius*	Umbrella plant, Umbrella papyrus, Umbrella sedge	Cyperaceae
17.	*Dieffenbachia amoena* Syn: *D.seguine*	Dumb cane	Araceae

Table 1. List of plants selected for study (Contd.,)

S. No.	Scientific name	Common name	Family
18.	*Dracaena marginata* Syn: *D.cincta*	Red edged dracaena, Madagascar dragon tree	Dracaenaceae
19.	*Dracaena* 'Purple Compacta'	Dracaena	Dracaenaceae
20.	*Dracaena sanderiana*	Ribbon plant	Dracaenaceae
21.	*Ficus benjamina*	Weeping fig, Benjamin bush, weeping willow	Moraceae
22.	*Homalomena wallisii*	Silver shield	Araceae
23.	*Iris innominata*	Del Norte County Iris	Iridaceae
24.	*Kalanchoe blossfeldiana* Syn: *Bryophyllum*	Flaming katy	Crassulaceae
25.	*Licuala grandis* Syn: *Pritchardia grandis*	The Raffled Fan palm	Arecaceae
26.	*Nephrolepis exaltata*	Boston fern	Polypodiaceae
27.	*Ophiopogon jaburan*	Ribbon grass	Liliaceae
28.	*Ophiopogon jaburan* 'Variegata'	Ribbon grass	Liliaceae
29.	*Peperomia clusiifolia*	Red-edged peperomia	Piperaceae
30.	*Peperomia obtusifolia* 'Sensation'	Baby rubber plant	Piperaceae
31.	*Philodendron* 'Ceylon Gold'	Golden Philodendron	Araceae
32.	*Philodendron elegans*	Skeleton Key Aroid	Araceae
33.	*Philodendron wendlandii*	Bird's nest philodendron	Araceae
34.	*Pleomele reflexa*	Dragon tree	Liliaceae
35.	*Polyscias guilfoylei*	Ceylon leaved panax	Araliaceae
36.	*Polyscias paniculata* 'Variegata'	Weeping Variegated aralia	Araliaceae

Table 1. List of plants selected for study (Contd.,)

S. No.	Scientific name	Common name	Family
37.	*Rhapis excels*	Bamboo palm	Arecaceae
38.	*Rhoeo discolor* Syn: *R. Spathacea*	Moses in the cradle, Oyster plant	Commelianaceae
39.	*Sansevieria trifasciata* 'Hahnii'	Silver Birdnest Sansevieria	Liliaceae
40.	*Sansevieria trifasciata* 'Laurentii'	Goldband Sansevieria	Liliaceae
41.	*Schefflera arboricola* Syn: *Brassaia, Heptopleurum*	Hawaiian elf/Dwarf Schefflera	Araliaceae
42.	*Scindapsus aureus*	Golden pothos	Araceae
43.	*Scirpus cernuus* Syn:*Isolepis cernua*	Scirpus grass	Cyperaceae
44.	*Spathiphyllum wallisii*	Peace lily	Araceae
45.	*Syngonium podophyllum* Syn: *Nephthytis triphylla*	Arrowhead vine	Araceae
46.	*Syngonium wendlandii*	Silver Goosefoot plant	Araceae
47.	*Tacca chantrieri*	Bat plant	Taccaceae
48.	*Tillandsia stricta*	Air plant	Bromeliaceae
49.	*Tradescantia spathacea* 'Sitara' Syn: *T.discolor, T.bicolor*	Oyster plant	Commelinaceae
50.	*Zamioculcas zamiifolia*	Zanzibar Gem	Zamiaceae

3.3.4. Design of the experiment

For experiment conducted in different growing structures a completely randomised block design with three replications and each with five plants was laid out.

3.3.5. Observations

In each species three plants were used for recording biometric observations. The parameters recorded during the course of the experiment are the following:

Plate 3. Rosette type foliage plants

3.1. *Anthurium crystallinum*

3.2. *Begonia rex*

3.3. *Calathea ornata 'Roseo-lineata'*

3.4. *Calathea zebrina*

3.5. *Homalomena wallisii*

3.6. *Philodendron wendlandii*

3.7. *Rhoeo discolor*

3.8. *Tillandsia stricta*

3.9. *Tradescantia spathacea 'Sitara'*

Plate 4. Tree-like foliage plants

4.1. *Chrysalidocarpus lutescens*

4.2. *Codiaeum variegatum* 'Delaware'

4.3. *Codiaeum variegatum* 'Punctatum aureum'

4.4. *Ficus benjamina*

4.5. *Licuala grandis*

4.6. *Polyscias guilfoylei*

4.7. *Polyscias paniculata* 'Variegata'

4.8. *Rhapis excelsa*

4.9. *Schefflera arboricola*

Plate 5. Flowering foliage plants

5.1. *Anthurium andreanum* 'Bonina'

5.2. *Chrysothemis pulchella*

5.3. *Costus curvibracteatus*

5.4. *Iris innominata*

5.5. *Kalanchoe blossfeldiana*

5.6. *Spathiphyllum wallisii*

5.7. *Tacca chantrieri*

Plate 6. Upright foliage plants

6.1. *Aglaonema nitidum* 'Curtisii'

6.2. *Aglaonema pseudobracteatum*

6.3. *Alpinia zerumbet* 'Variegata'

6.4. *Dieffenbachia amoena*

6.5. *Dracaena* 'Purple Compacta'

6.6. *Dracaena marginata*

6.7. *Dracaena sanderiana*

Plate 6. Upright foliage plants (Contd.)

6.8. *Nephrolepis exaltata*

6.9. *Peperomia clusiifolia*

6.10. *Peperomia obtusifolia* 'Sensation'

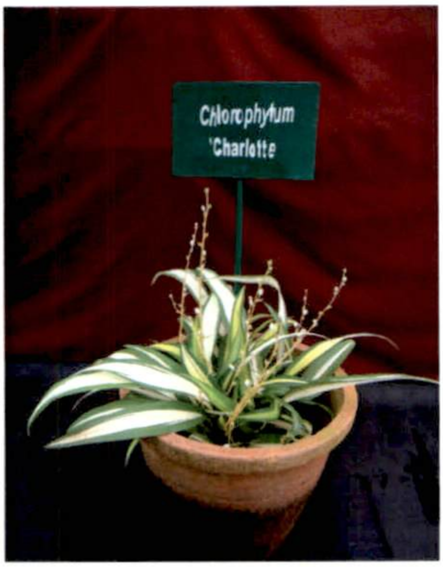
6.11. *Pleomele reflexa*

6.12. *Sansevieria trifasciata* 'Hahnii'

6.13. *Sansevieria trifasciata*

6.14. *Zamioculcas zamiifolia*

Plate 7. Grass-like foliage plants



7.1. *Chlorophytum* 'Charlotte'

7.2. *Cyperus alternifolius*

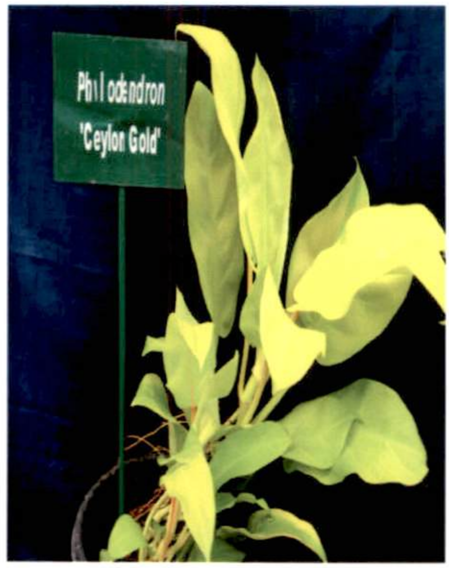
7.3. *Ophiopogon jaburan*

7.4. *Ophiopogon jaburan* 'Variegata'

7.5. *Scirpus cernuus*

Plate 8. Climbing and trailing foliage plants

8.1. *Asparagus setaceus*



8.2. *Philodendron* 'Ceylon Gold'

8.3. *Philodendron elegans*

8.4. *Scindapsus aureus*

8.5. *Syngonium podophyllum*

8.6. *Syngonium wendlandii*

3.3.5.1. Quantitative characters

3.3.5.1.1. Plant height

The height of the plant was measured from collar region to the tip of the youngest mature leaf at weekly intervals and expressed in centimetres.

3.3.5.1.2. Plant spread

The spread of the plant in East West and North South directions were measured and recorded in centimetres

3.3.5.1.3. Number of leaves

The total number of leaves present on the plant at the time of each observation was counted and recorded.

3.3.5.1.4. Length of leaves

The length of the leaf from the basal lobe to the tip was measured and expressed in centimetres.

3.3.5.1.5. Breadth of leaves

Maximum leaf width at the centre of the leaf was measured and expressed in centimetres.

3.3.5.1.6. Leaf area

Dot method (Bleasdale, 1977) was used to measure the leaf area and the same was expressed in square centimetres.

3.3.5.1.7. Petiole length

The length of the petiole from the point of its emergence to the base of the leaf lamina was measured and recorded in centimetres

3.3.5.1.8. Petiole girth

The circumference of the middle portion of the petiole was measured and expressed in centimetres as the petiole girth

3.3.5.1.9. Internodal length

The length between two successive nodes was measured and expressed in centimetres.

3.3.5.1.10. Leaf producing interval

Time interval (days) between the emergence of two successive leaves was counted and recorded.

3.3.5.1.11. Longevity of leaves

Longevity was measured in days from the day the leaf is fully unfurled to the day the leaf became unfit (as indicated by drying, wilting, twisting, drooping, yellowing, blackening, etc.).

3.3.5.1.12. Flower type

Type of the flower produced were observed

3.3.5.1.13. Longevity of flower on plant

The number of days from the opening of the flower till the flower shows symptoms of wilting on the plant was recorded.

3.3.5.1.14. Interval of flower production

The number of days taken for the emergence of successive flower/inflorescence was recorded.

3.3.5.1.15. Total number of flowers per plant

Total number of flowers in each observational plant was counted.

3.3.5.1.16. Flower size

Maximum length and breadth of flower was measured and recorded in centimetres.

3.3.5.1.17. Incidence of pests and diseases

Plants were observed for the incidence of pests and diseases, if any.

3.3.5.2. Qualitative characters

Leaf characters, which directly contributed towards their use as cut foliage, were observed.

3.3.5.2.1. Texture-smooth, verrucose, leathery, cereous

3.3.5.2.2. Shape-linear, lanceolate, ovate, cordate

3.3.5.2.3. Margin-entire, wavy, serrate, palmatifid

3.3.5.2.4. Tip- acute, obtuse, mucronate

3.3.5.2.5. Bending/drooping of leaves

3.3.5.2.6. Pigmentation-colour changes during maturity

3.3.5.2.7. Plant quality rating

The foliage plant species were rated according to their fullness, growth, tolerance capacity (suitability to indoor conditions) and visual appearance *viz.*, colour and pigmentation, texture, shape and pattern and size of the foliage during the growth period. The grades ranged from 1-10 for each character and its totalling to each species.

Other qualitative characters like appearance, colour, fading and fragrance of flowers were also observed and recorded.

3.3.5.3. Other characters

Other general characters of the plants, such as, branching habit, flower production, type of flower produced and incidence of pests and diseases were also recorded.

3.3.5.4. Weather parameters

Daily readings of temperature (maximum and minimum), relative humidity and light intensity were recorded at 0900 and 1500 hrs.

3.4. Evaluation of susceptibility levels of plants to air pollution

Air Pollution Tolerance Index (APTI) of foliage plants was computed during three different periods (March-April, June-July and October-November) after determining four parameters viz., ascorbic acid, total chlorophyll, relative water content and leaf extract pH. The plants were categorized into sensitive (≤ 10), intermediate (11 to 14), moderately tolerant (15 to 18) and tolerant (>18) based on APTI values. The air pollution tolerance index [APTI] was computed and plants were categorized by the method and values respectively suggested by Singh *et al.* (1991) using the equation:

$$APTI = [A (T+P) + R] / 10$$

Where, A = Ascorbic acid content (mg/g)

T = Total chlorophyll (mg/g)

P = pH of leaf extract and

R = Relative water content of leaf (%)

Fully mature physiologically active leaves (third or fourth from above) in triplicates were collected in morning hours and the fresh leaf samples were analyzed for total chlorophyll, ascorbic acid, leaf extract pH and relative water content. Chlorophyll was extracted in 80% acetone and the absorption at 663 nm and 645 nm were read in a spectrophotometer. Using the absorption coefficients, the amount of chlorophyll was calculated (Arnon, 1949). For the determination of ascorbic acid content, a homogenate was prepared by using 4% oxalic acid, and was dehydrogenated by bromination. The dehydroascorbic acid was then treated with 2, 4-nitrophenyl hydrazine to form osazone and dissolved in sulphuric acid to give an orange-red colour solution which was measured at 540 nm (Sadasivam and Manickam, 1996). Fresh leaf (0.5 g) sample was homogenized using 50 ml distilled water and the supernatant was fed into digital pH meter for detection of pH (Varshney, 1992). The percentage relative water content was calculated by using the initial weight, turgid weight and dry weights of leaf samples (Beadle *et al.*, 1993).

Transpiration rate was directly recorded with Infra Red Gas Analyser (IRGA) (LI-6400 Portable photosynthesis system, LI-COR Biosciences, Inc., USA).

Plate 9. Evaluation of selected foliage plants under indoor conditions

9.1. Low light intensity zone (LL)
(<800 lux)

9.2. Medium light intensity zone (ML)
(800-2000 lux)

9.3. High light intensity zone (HL)
(>2000 lux)

9.4. Supplementary light zone (SL)
(800-2000 lux)

9.5. Air conditioned supplementary light zone (A/C) (800-2000 lux)

3.5. Evaluation under indoor conditions

Plants found suitable for interior plantscaping were selected based on their APTI values and were evaluated under different indoor light conditions.

3.5.1. Light intensities

i) Low light: less than 800 lux

ii) Medium light: 800-2000 lux

iii) High light: more than 2000 lux

iv) With supplementary light (800-2000 lux) in non air conditioned rooms

v) With supplementary light (800-2000 lux) in air conditioned rooms

3.5.2. Observations

All the observations were taken as in 3.3.5

3.6. Estimation of air borne microbes filtering efficiency of indoor plants

Petri dishes containing standard plate count agar (PCA) were used to collect and culture airborne microbes. Lids from petri dishes were removed during each four-hour exposure period. Upon completion of each four-hour exposure, lids were replaced on petri dishes. Dishes were then placed in an incubator at 28° C for 48-hours. After 48-hous, petri dishes were removed from the incubator and the number of "colony forming units' (cfu) were recorded (Wolverton and Wolverton, 1996). Petri dishes were placed at different light intensities viz., High (>2000 lux), Medium (800-2000 lux), low (<800), with supplementary light in air conditioned room (800-2000 lux), with supplementary light in non air conditioned room (800-2000 lux) along with the plants Petri dishes were kept in the same locations without plants for obtaining control counts.

3.7. Estimation of dust particles filtering efficiency of indoor plants

The dust filtering efficiency of indoor plants was estimated adopting the method of Kulshreshtha *et al.* (2009). Leaves of different foliage species kept indoor were washed thoroughly with distilled water using a hairbrush and the water was collected in petri dishes. This dusty water was then completely evaporated in an oven at 100°C and weighed with an electronic balance up to three decimal point precision to record the total dust quantity trapped. The leaf area (cm^2) was recorded using dot method (Bleasdale, 1977). The amount of dust was calculated following the equation:

$W = (w_2 - w_1)/n$

Where,

W = amount of dust (mg/cm^2),

w_1 = initial weight of the petri dish without dust

w_2 = final weight of the petri dish with dust,

n = total area of the leaf (cm^2).

3.8. Statistical analysis

Statistical analysis of the data collected was done by adopting the standard procedure of Panse and Sukhatme (1978) and using the software AGRES for general analysis and SPSS for correlation studies. The critical difference was worked out at five per cent (0.05) probability.

Results

4. RESULTS

4.1. Evaluation under two growing systems

The performance of fifty foliage species under greenhouses having different ventilation systems *viz.*, open ventilation (OV) and, fan and pad (FP) was evaluated. The foliage species consisted of plants with different growth habit/pattern. They were categorized according to their nature of growth and appearance to rosette, tree like, flowering, upright, grass like and climbing and trailing for a more systematic comparison.

4.1.1. PLANT CHARACTERS

Plant characters like height, spread, number of leaves, leaf area, internodal length, leaf producing interval etc were observed monthly for one year and the results are presented here.

4.1.1.1. Quantitative characters

4.1.1.1.1. Plant height (cm)

Plant height significantly varied among the species in all the categories (Table 2).

However, among the rosette type, there was no significant difference between the growing systems and its interaction with species throughout the experiment period except for the first month. The plants kept in fan and pad greenhouse (FP) exceeded the growth in open ventilated greenhouse (OV). The highest plant height was observed in *Tillandsia stricta* throughout the year except the last month when the maximum height was observed in *Calathea ornata* 'Roseo-lineata'. Though it reached the maximum height in the last month, it was on par with the highest value during the first, eighth, ninth, tenth and eleventh months. The other plants on par with the maximum height were *Rhoeo discolor*, *Philodendron wendlandii* and *Anthurium crystallinum* during different months of observation. The lowest height was observed in *Begonia rex* and *Homalomena wallisii* throughout the year and they were on par with *Tradescantia spathacea* 'Sitara' throughout the year except in the 5th month, *Calathea zebrina* during 2nd, 3rd, 10th and 11th months and *Rhoeo discolor* during the last three months.

When plant height of tree-like species was compared, the growing systems showed significant difference between them up to 10th month. But the interaction effects were not significant. The plants kept in FP exceeded the growth of plants in OV. The highest and the lowest plant heights were observed in *Chrysalidocarpus lutescens* and *Rhapis excelsa* throughout the year respectively. Height of *Ficus benjamina* was on par with the highest value during the last five months. *Codiaeum variegatum* 'Delaware', *Licuala grandis* and *Polyscias paniculata* 'Variegata' were the species having the lowest height which were on par during different months.

The flowering plants grown in FP reached the maximum height than in OV during the first seven months, 10th month and 11th month and for the rest of the period there was no significant difference. *Costus curvibracteatus* was observed to have maximum height throughout the year and it was on par with *Iris innominata* during 1st, 2nd, 4th, 5th, 6th and 12th months. *Chrysothemis pulchella* had the lowest height and it was on par with *Kalanchoe blossfeldiana*, *Spathiphyllum wallisii* and *Anthurium andreanum* 'Bonina' during the first seven months, the last eight months and the last month respectively.

Among upright foliage plants, *Nephrolepis exaltata* and *Peperomia clusiifolia* were the plants that possessed the highest and the lowest heights respectively. *Dieffenbachia amoena* and *Dracaena marginata* were on par with the highest value during the first, second and third months respectively. *Sansevieria trifasciata* 'Hahnii' was on par with the lowest value during the last two months. Among the growing systems, plants in FP were found to have more height than the other. Interaction between species and growing systems also showed significant differences during 3rd, 4th, 5th, 7th, 8th, 9th and 10th months. *Nephrolepis exaltata* had the maximum height in both growing systems and *Peperomia clusiifolia* in FP had the minimum height. The other significant combinations produced maximum height during the mean period was *Dieffenbachia amoena* in OV and FP, *Dracaena* 'Purple Compacta' and *Dracaena marginata* in FP.

In grass-like plants, *Cyperus alternifolius* and *Chlorophytum* 'Charlotte', respectively, had the highest and the lowest heights throughout the year. The height of *Scirpus cernuus* was on par with the lowest height during the first and the last four months. During 3rd, 4th and 5th months, plants kept in FP had outgrown the plants kept in other system. Interaction effect produced significant result during 4th month when *Cyperus alternifolius* (90.9 cm) in FP had the maximum height and *Chlorophytum* 'Charlotte' (12.7 & 15.7 cm) in both OV and FP and *Scirpus cernuus* (18.1 cm) in OV had the minimum heights.

Unlike other category of plants, growth of climbing and trailing types was significantly good in OV compared to FP, during the second and third months, after which

Table 2: Height of foliage plants in two growing systems in different months

S. No.	Plant species	Plant height (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	36.2	26.6	38.6	27.4	39.9	34.7	40.6	36.1	42.5	38.0	43.0	39.7	45.6	43.4	46.8	45.6	48.7	45.8	49.3	47.6	50.0	52.3	51.4	54.0
2	*Begonia rex*	5.3	17.7	13.6	18.0	15.3	18.5	16.1	18.6	17.7	19.3	18.3	19.6	18.8	20.5	19.5	21.3	21.6	23.9	22.2	26.0	23.1	28.2	25.7	33.7
3	*Calathea ornata* 'Roseo-lineata'	28.4	21.4	30.7	23.5	32.0	27.7	35.9	30.3	40.4	31.7	46.1	33.7	49.0	36.7	54.4	54.6	55.8	62.3	64.8	66.5	72.8	70.0	103.8	80.0
4	*Calathea zebrina*	17.2	23.8	19.0	26.2	20.3	27.1	21.9	29.4	22.6	30.4	23.7	33.7	24.5	34.5	26.0	35.9	31.5	38.3	33.0	40.3	33.0	43.5	36.6	48.9
5	*Homalomena wallisii*	9.8	15.6	11.4	17.7	13.1	17.8	14.9	18.2	15.3	19.6	15.9	20.9	18.3	22.0	19.1	23.3	20.2	23.7	20.9	26.9	22.0	29.4	24.4	20.5
6	*Philodendron wendlandii*	20.3	29.5	24.4	31.3	26.8	33.7	27.5	40.1	29.4	44.3	33.1	45.4	36.5	47.5	37.5	48.2	39.1	50.8	40.9	51.6	41.9	52.9	45.5	55.7
7	*Rhoeo discolor*	18.8	28.4	21.0	32.1	21.6	32.9	22.7	33.3	23.6	33.9	24.1	34.4	26.9	35.0	28.4	35.6	29.8	36.4	30.9	42.2	32.6	44.8	33.2	34.2
8	*Tillandsia stricta*	29.9	29.3	44.5	31.6	40.3	36.6	44.9	38.9	52.5	45.2	55.6	52.6	50.6	55.1	56.2	55.7	50.8	56.3	55.6	62.8	58.0	64.8	58.5	65.7
9	*Tradescantia spathacea* 'Sitara'	10.5	20.4	20.5	22.2	16.6	24.8	20.2	26.3	24.2	28.0	24.8	29.4	22.5	30.2	25.2	30.6	23.8	32.4	25.7	33.5	26.2	36.9	25.2	36.2
CD (0.05)	*Species*	0.78**		8.41		8.26		7.63		8.07		9.53		9.74		10.53		11.01		14.02		16.63		15.06	
	Systems	0.37**		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
	Species x Systems	NS**		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
	Tree like																								
10	*Chrysalidocarpus lutescens*	76.2	87.7	81.1	91.4	84.1	94.8	89.7	102.1	97.7	104.7	110.1	120.7	113.1	127.7	115.8	130.3	120.7	143.7	121.1	151.2	142.8	158.2	150.9	163.3
11	*Codiaeum variegatum* 'Delaware'	48.3	44.5	50.7	45.4	58.2	47.2	59.9	48.8	60.3	50.5	62.5	52.3	64.8	53.9	66.7	55.4	69.6	57.5	73.2	59.9	74.1	61.3	81.0	64.4
12	*Codiaeum variegatum* 'Punctatum aureum'	33.5	48.8	43.3	51.8	47.8	55.2	54.7	64.1	59.9	69.3	64.2	79.2	72.8	82.3	87.8	85.1	93.5	91.5	97.6	93.8	101.0	97.3	103.6	101.0
13	*Ficus benjamina*	47.0	68.1	53.4	69.7	59.9	71.3	66.2	78.6	73.9	93.7	84.2	105.3	89.4	117.4	100.0	121.0	109.9	126.1	124.1	128.7	137.6	134.5	147.4	137.4
14	*Licuala grandis*	51.9	53.1	54.3	56.4	58.1	59.3	60.2	60.3	61.4	63.6	61.9	65.4	62.8	68.6	64.9	69.3	65.9	71.4	67.3	79.7	69.0	82.4	70.4	84.7
15	*Polyscias guilfoylei*	40.6	42.8	46.0	50.8	50.6	57.4	57.6	65.5	63.6	73.8	67.7	85.5	76.4	93.6	82.6	98.0	92.2	103.5	104.2	106.3	120.6	108.7	132.4	110.1
16	*Polyscias paniculata* 'Variegata'	22.5	41.6	28.1	43.9	35.3	49.2	42.8	52.5	52.3	57.4	60.1	58.6	67.8	61.7	72.1	62.7	75.3	63.4	79.7	69.1	81.1	72.1	83.5	75.2
17	*Rhapis excelsa*	24.2	33.9	25.6	36.2	25.9	40.1	27.4	45.9	27.9	51.6	28.0	57.7	28.6	67.4	31.7	69.4	35.3	71.9	37.2	78.5	41.1	80.3	42.8	82.6
18	*Schefflera arboricola*	29.2	50.9	38.1	54.1	43.8	58.1	51.5	66.6	60.8	72.4	72.4	82.9	78.0	90.9	86.0	98.6	92.3	107.3	97.0	115.9	105.4	117.5	110.1	119.7
CD (0.05)	*Species*	10.96		9.96		9.48		9.30		12.22		12.48		15.20		14.98		15.43		16.03		18.92		19.59	
	Systems	5.17		4.69		4.47		4.38		5.76		5.88		7.16		7.06		7.27		7.55		NS		NS	
	Species x Systems	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	18.4	24.9	20.7	26.3	21.7	26.4	24.5	29.1	25.2	32.8	28.7	34.8	30.3	36.5	31.6	38.3	34.3	38.8	35.6	39.8	37.7	42.3	38.7	50.4
20	*Chrysothemis pulchella*	9.3	15.0	11.8	15.6	16.5	17.5	17.2	20.6	19.1	22.7	20.0	27.2	23.0	28.4	24.6	29.4	25.9	29.7	26.2	31.9	28.1	33.8	52.1	37.4
21	*Costus curvibracteatus*	25.9	49.5	31.0	52.2	37.4	56.6	38.5	56.6	38.6	60.4	39.2	62.6	48.8	65.8	52.3	68.9	54.6	70.4	56.7	80.5	59.3	82.5	59.9	89.0
22	*Iris innominata*	33.5	35.9	36.6	38.9	38.7	40.4	40.6	42.2	42.7	42.8	44.5	43.3	49.3	43.7	50.5	46.1	51.7	47.6	53.5	51.5	57.3	55.8	64.5	56.8
23	*Kalanchoe blossfeldiana*	8.3	14.0	14.2	17.8	16.8	19.4	19.0	21.5	21.3	25.4	24.5	27.1	32.7	28.8	36.9	31.3	39.4	35.1	40.9	47.3	50.6	50.9	53.1	51.5
24	*Spathiphyllum wallisii*	20.5	23.6	24.6	24.4	24.3	26.4	25.1	27.5	27.4	27.8	28.2	28.4	26.9	29.8	29.1	30.9	27.9	32.1	29.2	33.9	29.8	37.2	31.5	38.4
25	*Tacca chantrieri*	19.2	21.1	29.1	23.3	22.1	28.2	29.4	33.1	38.8	37.4	41.6	39.6	41.2	41.0	47.1	41.7	42.9	43.8	45.9	47.8	49.1	51.1	49.3	53.9
CD (0.05)	*Species*	0.5**		6.83		5.45		6.62		7.75		7.84		7.00		6.69		7.19		7.48		7.17		14.52	
	Systems	0.27**		3.65		2.91		3.53		4.14		4.19		NS		NS		NS		4.00		3.83		NS	
	Species x Systems	NS**		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 2: Height of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Plant height (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	42.8	49.5	44.4	52.7	49.4	56.7	54.6	57.1	57.4	59.2	61.1	62.4	62.7	63.1	64.4	65.5	64.8	67.6	66.2	69.4	71.9	72.5	72.6	77.3
27	*Aglaonema pseudobracteatum*	52.2	49.4	55.7	56.7	60.5	62.7	62.5	65.6	63.1	68.7	63.9	70.7	65.4	72.1	66.0	74.0	69.2	77.8	70.1	82.0	71.4	83.5	72.9	90.3
28	*Alpinia zerumbet* 'Variegata'	26.8	22.2	36.4	22.9	40.5	23.8	43.1	24.9	44.1	28.3	45.7	32.9	47.0	34.7	47.6	38.2	49.8	39.7	50.0	41.3	51.3	47.2	54.1	58.1
29	*Dieffenbachia amoena*	69.1	77.8	70.2	80.2	73.8	84.2	76.1	89.8	79.3	90.5	82.4	92.1	87.0	93.8	89.6	95.8	98.8	97.7	105.4	100.8	108.7	103.6	111.6	107.5
30	*Dracaena* 'Purple Compacta'	44.8	75.8	48.8	78.2	52.5	84.0	59.1	88.8	61.7	94.9	65.8	98.3	69.0	100.6	71.4	102.5	73.6	104.4	75.3	106.8	77.0	108.4	78.3	113.3
31	*Dracaena marginata*	56.6	69.0	59.9	69.9	67.3	71.8	75.0	74.1	79.8	78.9	86.9	87.6	91.8	91.3	99.0	94.2	105.8	94.9	107.9	99.5	113.0	101.1	115.4	106.8
32	*Dracaena sanderiana*	35.9	44.7	44.6	48.2	49.8	55.1	54.2	61.3	56.6	67.3	60.6	72.4	67.6	77.8	72.2	80.4	78.4	85.2	84.3	88.1	87.3	91.2	88.6	96.5
33	*Nephrolepis exaltata*	61.0	65.4	71.9	71.3	86.8	87.3	103.6	93.3	107.2	117.2	118.0	137.2	126.2	143.9	152.8	147.2	157.6	149.0	161.8	157.6	170.8	165.3	181.1	177.1
34	*Peperomia clusiifolia*	9.2	6.1	10.0	7.1	11.1	7.2	13.5	7.7	14.0	8.0	15.9	8.4	18.3	11.5	20.5	11.6	20.8	12.0	21.4	12.1	21.8	19.2	23.1	22.4
35	*Peperomia obtusifolia* 'Sensation'	17.2	20.5	18.7	22.2	19.1	26.6	19.9	29.5	22.5	33.2	26.3	36.9	27.1	40.2	28.7	42.6	29.5	45.0	30.5	48.5	31.4	50.4	32.8	51.8
36	*Pleomele reflexa*	38.4	50.7	47.9	52.5	53.7	58.4	65.5	60.8	73.4	69.4	83.7	80.8	96.9	85.2	108.3	90.7	115.2	92.6	124.2	106.0	129.1	112.0	136.6	113.8
37	*Sansevieria trifasciata* 'Hahnii'	12.6	13.8	13.1	15.6	13.3	18.8	13.8	20.4	15.3	21.0	20.8	21.3	21.9	22.7	22.2	23.2	22.6	24.0	23.4	24.4	24.3	25.8	26.3	26.3
38	*Sansevieria trifasciata* 'Laurentii'	44.2	60.3	48.9	61.5	52.9	64.4	55.9	67.7	62.4	69.6	68.3	73.0	68.8	73.3	69.3	73.4	69.8	74.5	70.8	78.4	71.9	82.0	72.7	82.5
39	*Zamioculcas zamiifolia*	18.9	25.3	24.7	26.5	19.8	29.7	20.3	30.8	30.3	34.2	31.0	39.2	28.5	43.1	40.0	47.6	37.4	48.7	38.4	48.8	44.9	54.4	42.7	55.7
CD (0.05)	*Species*	0.8**		0.75**		0.68**		0.66**		0.67**		0.73**		0.64**		0.64**		0.67**		0.72**		12.92		13.32	
	Systems	0.3**		0.28**		0.25**		NS**		0.25**		0.27**		0.24**		NS**		NS**		NS**		NS		NS	
	Species x *Systems*	NS**		NS**		0.96**		0.94**		0.96**		NS**		0.91**		0.91**		0.95**		1.02**		NS		NS	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	10.4	11.9	11.1	13.4	11.4	13.6	12.7	15.7	13.8	17.4	15.3	17.8	16.3	18.7	16.8	19.9	19.5	21.0	21.5	21.4	24.0	22.8	27.2	26.2
41	*Cyperus alternifolius*	58.8	53.9	61.3	55.9	62.6	71.1	67.0	90.9	73.2	94.4	88.7	98.0	94.4	99.1	96.3	101.4	98.2	108.1	99.1	111.9	100.9	115.2	108.5	119.4
42	*Ophiopogon jaburan*	23.7	31.5	26.7	33.7	36.8	37.8	38.8	41.9	40.6	43.2	42.8	44.9	45.3	46.0	47.2	46.7	49.3	49.6	52.7	53.5	54.7	55.8	59.1	56.5
43	*Ophiopogon jaburan* 'Variegata'	23.5	22.4	27.1	27.9	29.6	36.8	31.3	39.1	33.0	40.9	35.0	42.7	38.6	44.5	41.4	47.0	42.6	49.2	43.1	51.6	44.3	54.3	47.0	54.2
44	*Scirpus cernuus*	12.8	14.9	18.7	17.5	15.5	20.2	18.1	23.0	23.3	23.9	24.6	24.7	23.2	25.8	25.4	27.7	24.0	29.5	27.0	31.2	27.7	32.5	27.7	32.8
CD (0.05)	*Species*	0.64**		0.58**		0.46**		4.69		5.99		7.41		6.48		6.67		8.00		8.16		8.77		9.15	
	Systems	NS**		NS**		0.29**		2.96		3.79		NS		NS		NS		NS		NS		NS		NS	
	Species x *Systems*	NS**		NS**		NS**		6.63		NS		NS		NS		NS		NS		NS		NS		NS	
	Climbing & Trailing																								
45	*Asparagus setaceus*	39.5	54.3	42.0	56.2	50.3	59.0	57.1	96.2	58.7	132.2	83.8	145.6	142.0	156.1	151.3	176.2	159.3	197.9	167.0	211.9	172.1	227.3	177.8	237.7
46	*Philodendron* 'Ceylon Gold'	24.5	33.4	41.7	36.3	46.0	43.4	54.7	60.7	60.2	80.5	68.3	106.8	85.1	112.7	93.4	129.0	98.3	136.0	107.8	136.9	115.2	156.8	127.9	172.3
47	*Philodendron elegans*	23.9	29.3	25.8	31.4	27.2	43.6	39.7	52.5	45.0	58.9	51.9	75.7	64.6	87.6	75.7	108.2	76.9	115.7	88.6	123.9	93.0	135.3	99.5	151.0
48	*Scindapsus aureus*	98.5	31.4	122.9	37.1	146.4	50.8	201.9	73.4	224.7	93.7	250.0	120.6	282.7	136.6	307.7	147.3	319.3	157.8	333.5	165.0	343.1	171.7	358.2	177.0
49	*Syngonium podophyllum*	44.9	22.1	89.3	24.1	65.5	29.1	75.5	43.1	123.0	60.0	130.4	70.5	90.4	83.0	152.0	95.5	122.6	106.8	149.6	116.4	162.0	120.2	164.8	129.5
50	*Syngonium wendlandii*	10.9	13.0	26.1	15.3	24.6	20.1	33.5	41.0	46.3	70.1	51.1	88.2	42.3	94.9	54.1	105.6	49.8	110.6	51.3	113.7	54.5	118.4	59.3	122.9
CD (0.05)	*Species*	1.07**		25.57		17.33		26.18		37.33		44.07		41.51		43.32		48.28		47.23		50.32		51.98	
	Systems	NS**		14.76		10.01		NS		NS		NS		NS		NS		NS		NS		NS		NS	
	Species x *Systems*	1.52**		36.16		24.52		37.03		52.79		62.32		58.70		61.27		68.28		66.79		71.17		73.52	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

there was no significant difference. The highest and the lowest heights were observed in *Scindapsus aureus* and *Syngonium wendlandii* respectively throughout the year. *Asparagus setaceus* and *Syngonium podophyllum* were having the maximum heights which were on par during the first and second months respectively. The height of *Philodendron elegans* was on par with the lowest throughout the year except for the first month, *Philodendron* 'Ceylon Gold' during 2nd, 4th and 11th months and *Syngonium podophyllum* during 4th, 6th, 7th and 9th months. The interaction effects were significant in *Scindapsus aureus* (358.2 cm during the last month) in OV throughout the year and it was on par with *Syngonium podophyllum* (164.8 cm during the last month) in OV. *Syngonium podophyllum* (129.5 cm during the last month) in FP. *Syngonium wendlandii* (59.3 & 122.9 cm during the last month) in both the systems maintained the least height throughout the year. The other combinations having height at par with the least value were as follows: *Scindapsus aureus* (37.1 & 93.7 cm) in FP during 2nd and 5th months; *Syngonium podophyllum* (90.4 & 83.0 cm) in both OV & FP during 7th month; *Asparagus setaceus* (42, 57.1, 58.7, 83.8 cm) in OV during 2nd, 4th, 5th and 6th months; *Philodendron* 'Ceylon Gold' (127.9 cm during the last month) in OV throughout the year except 1st and 3rd months; in FP (36.3, 43.4, 60.7, 80.5 & 106.8 cm) between 2nd and 6th months; *Philodendron elegans* (76.9 & 115.7 cm during 9th month) in both systems during 2nd and 9th months; in OV alone (99.5 cm) during the last month.

4.1.1.1.2. Plant spread (cm^2)

The plant spread was recorded in two ways viz., north-south and east-west and presented by multiplying both the values in such a way to show the total area covered by a plant (Table 3). The plant spread of all climbing & trailing plants and *Nephrolepis exaltata* in upright plants were not taken as those plants were subjected to trimming/pruning due to the production of large number of runners.

When the rosette type foliage plants were observed for plant spread, there was significant difference between the species throughout the year. No significant difference was observed among the plants in the two growing systems. But the interaction effects were significant during 1st, 2nd, 8th, 9th, 10th and 11th months. Among the species, *Tillandsia stricta* had the maximum spread during all the months and the minimum spread was recorded in *Tradescantia spathacea* 'Sitara'. *Tillandsia stricta* in both OV and FP, *Begonia rex* in OV and *Philodendron wendlandii* and *Calathea ornata* 'Roseo-lineata' in FP had the maximum spread. *Tradescantia spathacea* 'Sitara' in OV and *Anthruium crystallinum* in FP had the minimum.

In tree-like plants, throughout the year, *Chrysalidocarpus lutescens* had the highest spread and the lowest spread was observed in *Polyscias guilfoylei* and *Polyscias paniculata* 'Variegata' which were on par with each other. During 1st, 2nd, 4th, 5th, 6th and 8th months, plants in FP recorded more spread than in OV. Interaction effects were significant only during 1st, 10th and 12th months when *Chrysalidocarpus lutescens* in OV had the maximum spread and *Polyscias guilfoylei* and *Polyscias paniculata* 'Variegata' in both systems had the least spread.

Among flowering plants, the maximum spread was observed in *Tacca chantrieri* throughout the year except in 7th month when *Costus curvibracteatus* had the maximum. The minimum spread was observed in *Kalanchoe blossfeldiana* throughout the year. Among the growing systems, FP excelled OV in most of the months except for the last month in which OV was better. Though different combinations produced the maximum and the minimum spread during the initial months, *Tacca chantrieri* in OV reached the maximum spread (6231.9 cm^2) and *Chrysothemis pulchella* (945.1 cm^2) also in OV had the minimum during the last month.

In upright plants, *Dieffenbachia amoena* and *Dracaena marginata* had the maximum spread throughout the year and they were at par. The minimum spread was observed in *Peperomia clusiifolia* and *Zamioculcas zamiifolia* throughout the year. No significant difference was observed among the plants in the two growing systems. During the last month, *Aglaonema pseudobracteatum*, *Dracaena marginata* and *Dieffenbachia amoena* in both the systems and *Aglaonema nitidum* 'Curtisii' in FP had the maximum spread and they were at par. *Zamioculcas zamiifolia* in both the systems and *Peperomia clusiifolia* in FP had the minimum spread.

When grass-like species were compared, the highest and the lowest spreads were recorded in *Cyperus alternifolius* and *Chlorophytum* 'Charlotte' respectively. *Ophiopogon jaburan* and *O. jaburan* 'Variegata' were on par with the highest value and *Scirpus cernuus* was on par with the lowest value during most of the months. There was no significant difference between the growing systems and also its interaction with species except during the 2nd month when the plants kept in OV had significantly more spread than the other.

Table 3:Spread (NS x EW) of foliage plants in two growing systems in different months

S. No.	Plant species	Plant spread (cm^2)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	3653.7	1049.5	3873.3	1049.5	3990.2	2515.2	3799.8	2412.5	4675.4	2555.3	4298.6	2446.5	4718.9	1789.4	6386.3	1658.6	3708.7	1387.1	3980.1	1551.6	3752.1	1600.2	4041.4	1715.5
2	*Begonia rex*	111.2	1448.7	558.3	1603.9	1081.9	1662.1	1121.4	2467.7	2355.2	2542.0	3570.0	3128.4	4339.7	3211.2	4583.2	2233.4	4775.0	2753.4	6405.2	2641.0	5922.3	2801.2	6819.1	2843.1
3	*Calathea ornata* 'Roseo-lineata'	1065.5	527.4	1120.3	527.4	1504.7	1332.9	1365.1	1164.6	1147.2	1622.5	1483.1	815.5	1281.7	848.4	1378.7	5062.2	1378.7	6184.3	1378.7	6279.9	1378.7	5189.9	6225.6	4091.8
4	*Calathea zebrina*	897.5	605.2	1431.3	605.2	997.6	742.5	969.3	1087.6	801.2	1435.5	700.0	1449.1	1001.7	1575.8	1205.8	2334.1	1270.5	3845.6	1270.5	4141.7	2350.6	4582.7	2606.5	4096.7
5	*Homalomena wallisii*	902.5	1655.4	1141.8	1655.4	1363.5	1702.1	1509.7	1924.2	1574.8	1988.8	1816.3	2038.4	1851.8	1948.1	2071.4	2098.6	2246.6	2139.2	2320.6	2198.2	2084.3	2378.2	1935.2	2337.7
6	*Philodendron wendlandii*	2214.6	2425.1	2110.0	2425.1	1710.8	2685.8	1782.8	2961.9	2020.9	3379.4	2286.5	3609.4	2662.9	3949.8	2133.0	4107.6	2883.0	4674.0	3380.8	4521.7	2828.2	5055.3	4370.7	4931.5
7	*Rhoeo discolor*	663.1	660.7	759.0	660.7	647.5	2316.3	618.3	2428.9	769.0	2873.2	2359.1	2993.8	2924.9	3508.8	3409.2	3608.2	3737.9	4346.8	4029.1	4114.0	4266.9	4125.4	4067.8	4273.8
8	*Tillandsia stricta*	2403.1	2120.4	2931.5	2120.4	3203.2	2874.3	3410.7	3386.4	3740.5	3970.4	4358.0	6377.1	5832.4	6309.7	5822.4	6258.1	5408.7	6774.2	7213.4	8554.4	7168.6	7800.8	8023.7	8884.3
9	*Tradescantia spathacea* 'Sitara'	353.4	1264.3	925.0	1085.1	1009.0	1248.3	1464.6	1562.9	1663.4	2070.8	1831.2	2238.4	1965.7	2555.6	2208.3	2643.1	2429.2	2826.8	2523.2	2770.2	2430.9	2859.7	2493.2	2679.5
CD (0.05)	*Species*	861.34		792.16		1212.18		1222.81		1444.41		1695.54		1566.30		1711.77		13.68**		14.69**		13.20**		15.15**	
	Systems	NS		NS		NS		NS		NS		NS		NS		NS		NS**		NS**		NS**		NS**	
	Species x Systems	1218.12		1120.28		NS		NS		NS		NS		NS		2420.81		19.35**		20.78**		18.67**		NS**	
	Tree like																								
10	*Chrysalidocarpus lutescens*	4127.5	5532.0	3996.5	5532.0	4942.8	4959.6	4752.3	6467.8	4970.4	8032.1	5533.1	6860.7	8290.7	8529.3	8250.0	11094.9	8820.1	11126.1	7927.0	11069.8	8814.1	11015.9	8540.9	11952.4
11	*Codiaeum variegatum* 'Delaware'	923.0	904.8	1235.5	904.8	1477.8	1756.5	1536.0	2205.9	1259.8	2730.3	1509.0	3414.3	962.6	3549.9	1946.8	3586.2	1911.3	2908.7	1614.2	2986.5	1584.8	3000.9	1779.2	2889.2
12	*Codiaeum va, iegatum* 'Punctatum aureum'	791.8	1481.5	1070.9	1481.5	1189.7	2354.0	1703.2	2545.7	2186.0	2551.3	2726.0	3231.9	2647.6	3298.7	2938.5	3265.0	3123.2	3374.8	2957.4	3434.3	3553.2	3224.5	3377.8	3385.5
13	*Ficus benjamina*	853.0	1801.9	1005.4	1801.9	1105.8	1777.8	1252.7	1903.7	1235.9	2348.8	1525.0	2158.2	1684.4	2198.9	1988.5	2841.2	2225.8	2347.7	2307.1	1895.3	1844.8	2274.4	1503.4	2184.7
14	*Licuala grandis*	4113.1	3857.3	3573.0	3857.3	3853.6	4049.8	4190.9	4665.1	4562.7	5723.3	5315.5	4647.0	6362.4	3865.8	5056.1	5067.0	5334.0	3703.0	5703.0	3539.8	6014.7	3561.7	5812.4	3661.9
15	*Polyscias guilfoylei*	468.1	407.9	593.4	396.0	731.3	551.5	753.1	583.6	1026.2	658.7	1026.5	750.4	1081.9	881.2	1369.2	1302.5	1390.2	1246.8	1398.9	1285.6	1419.6	1197.5	1527.7	1282.6
16	*Polyscias paniculata* 'Variegata'	240.2	860.3	644.1	860.3	762.8	1027.7	1166.3	1073.9	1336.6	889.7	1628.4	915.4	1735.2	1371.8	1652.4	1057.5	1678.3	702.2	1272.2	650.8	999.3	981.8	1288.3	762.1
17	*Rhapis excelsa*	1332.0	1613.9	1261.4	1613.9	1598.1	2012.5	1642.6	2578.1	1101.4	2697.3	1836.0	3454.9	1590.7	3858.2	1530.3	4274.8	1818.2	4365.2	1917.4	4831.3	2497.2	5082.6	2400.6	4900.3
18	*Schefflera arboricola*	1478.9	1343.2	1527.8	1343.2	1828.5	1870.9	1826.4	2465.6	2175.9	3208.0	2918.9	3460.0	3368.3	4341.6	3893.3	4627.4	4322.2	6397.4	5175.4	5696.0	5857.0	6451.3	5022.6	4984.2
CD (0.05)	*Species*	412.31		516.81		705.58		926.30		919.44		1020.19		1446.83		1241.38		1438.83		1290.42		1251.45		1301.21	
	Systems	194.24		243.43		NS		436.66		433.43		480.92		NS		585.19		NS		NS		NS		NS	
	Species x Systems	582.72		NS		NS		NS		NS		NS		NS		NS		NS		1824.94		NS		1840.19	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	866.5	822.8	851.4	822.8	926.3	1180.8	1196.4	1414.7	1022.2	1640.3	1513.7	1738.5	1860.6	1500.6	1749.9	1794.9	1546.6	1890.3	1844.9	2135.6	1686.0	2142.9	2135.1	2374.5
20	*Chrysothemis pulchella*	169.0	1169.9	71.6	1169.9	482.5	2158.5	1242.9	2116.3	1571.4	2097.9	1853.5	2505.8	2228.1	2444.1	2108.8	2405.8	2621.4	1782.7	2077.5	1074.0	827.0	805.6	945.1	1039.3
21	*Costus curvibracteatus*	302.7	1252.5	681.5	1252.5	2460.9	1252.5	867.1	1252.5	698.9	5304.5	698.9	5575.1	4559.6	6838.8	4430.6	4960.9	4712.0	4977.3	5525.0	6353.4	3189.0	3705.1	4933.3	2925.9
22	*Iris innominata*	374.5	1514.3	1238.3	1514.3	1212.7	1868.2	1502.4	2191.1	1774.6	2221.2	1997.9	2294.4	2227.9	2452.1	2271.6	2362.2	2148.2	2847.5	2219.3	2465.5	2444.6	2473.6	2472.2	2429.2
23	*Kalanchoe blossfeldiana*	166.3	364.1	180.4	398.1	247.3	533.7	421.6	754.7	755.5	1107.6	1113.6	1227.0	1395.2	980.4	1670.6	1102.1	1729.5	990.9	1727.7	1118.4	1654.7	1181.4	2204.8	1140.8
24	*Spathiphyllum wallisii*	2168.3	1480.6	2097.4	1480.6	1588.0	1739.8	2089.5	2037.6	2581.3	2378.8	2651.8	2909.1	3000.3	2951.7	3290.5	3508.7	3023.8	3431.9	2951.1	3653.0	2684.6	3488.8	3004.0	2781.8
25	*Tacca chantrieri*	1393.2	2200.4	2335.8	2200.4	3149.7	2243.3	3183.9	1420.2	2946.2	2625.7	2728.4	3833.4	3721.5	4322.4	4434.2	4174.4	4299.5	3879.1	5684.6	4552.8	5522.5	1690.7	6231.9	1826.8
CD (0.05)	*Species*	4.79**		4.04**		496.65		565.73		874.27		854.39		1107.57		1051.88		1050.47		969.82		930.32		1164.13	
	Systems	2.56**		2.16**		NS		NS		467.32		456.69		NS		NS		NS		NS		NS		622.25	
	Species x Systems	6.78**		5.71**		702.37		800.07		1236.41		1208.29		NS		NS		NS		NS		1315.67		1646.32	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 3:Spread (NS x EW) of foliage plants in two growing systems in different months (Contd.,)

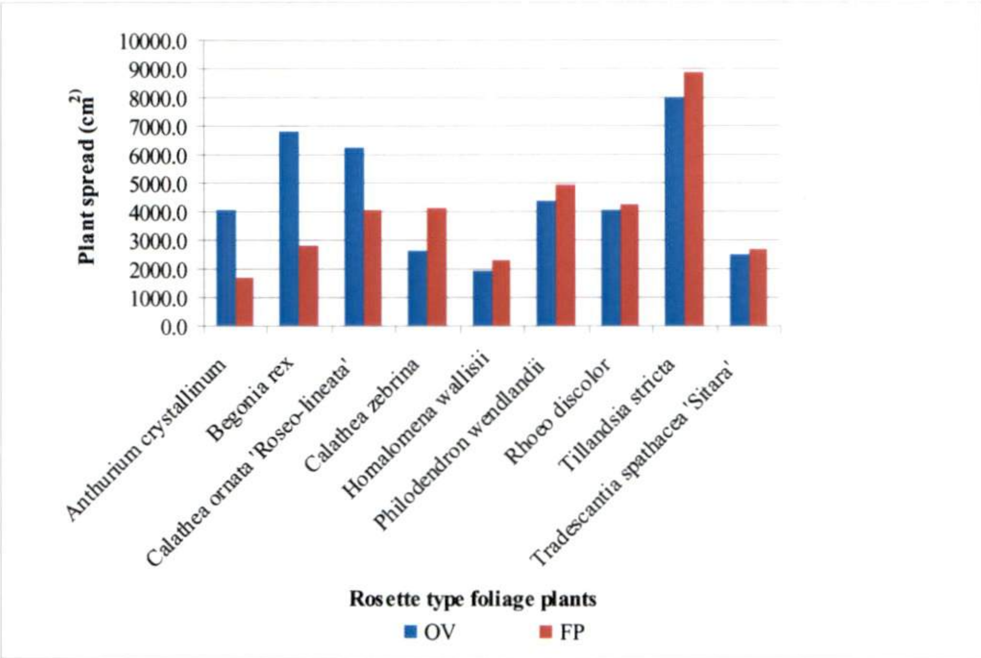
S. No.	Plant species	Plant spread (cm^2)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	2322.9	2831.4	1929.4	2895.0	2523.3	3119.4	3295.4	3253.7	3318.9	3637.6	3291.2	3273.4	3713.7	3244.1	2752.1	4057.8	2389.0	3550.0	2629.6	3280.6	2299.6	3522.1	2499.2	3097.0
27	*Aglaonema pseudobracteatum*	1402.1	1313.2	1552.6	1960.4	1779.0	2932.4	1692.9	3638.1	2465.9	4030.6	2674.3	4726.4	3197.8	4839.2	3198.3	4847.4	2077.3	4668.3	3089.3	4513.9	3614.8	4197.7	1676.5	4409.2
28	*Alpinia zerumbet* 'Variegata'	1051.0	1087.3	1058.7	1085.6	1189.2	917.4	1370.2	1030.0	1478.4	941.6	1468.7	1119.5	1360.8	1188.1	1573.7	935.5	1800.6	1478.3	1594.2	1131.2	1818.0	1245.7	1838.2	1412.5
29	*Dieffenbachia amoena*	3173.0	4562.1	3967.5	4562.1	3979.4	3936.6	4264.2	4076.2	4140.6	3814.9	3988.1	4225.9	4470.4	4134.5	4380.5	4654.6	4488.0	4417.5	4493.0	3894.6	4090.6	3565.2	4080.0	3879.0
30	*Dracaena* 'Purple Compacta'	632.8	476.1	625.5	476.1	734.8	535.3	672.7	600.6	922.5	643.8	999.3	689.0	996.8	695.4	1026.2	658.9	1006.1	666.3	1057.5	750.1	1013.1	729.8	1175.0	784.1
31	*Dracaena marginata*	2257.1	3642.5	3007.3	3717.3	3167.9	3659.5	3700.5	3963.3	3383.4	4022.8	3591.5	3871.7	3833.8	3579.9	3928.9	4137.8	3861.2	4012.9	4124.6	3874.8	4130.9	3342.0	4567.4	3378.2
32	*Dracaena sanderiana*	622.3	323.8	516.5	323.8	708.7	433.9	553.5	539.7	582.5	781.2	617.0	805.7	1050.7	1070.6	828.1	976.3	1245.6	1034.7	1049.3	1065.6	1029.7	1294.3	1261.8	1186.3
33	*Nephrolepis exaltata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	*Peperomia clusiifolia*	142.9	173.3	184.9	173.3	223.8	194.0	301.9	194.0	356.8	77.1	457.7	82.6	522.8	101.3	567.3	129.3	618.8	150.6	603.4	215.7	733.2	205.1	734.1	180.7
35	*Peperomia obtusifolia* 'Sensation'	167.6	356.3	249.1	356.3	329.7	2176.8	395.4	720.7	539.4	931.6	792.3	1119.6	1084.5	2103.2	1380.2	2401.3	1554.8	2089.6	1976.1	2845.6	2099.1	2635.0	2317.6	2464.1
36	*Pleomele reflexa*	550.1	668.5	590.0	668.5	698.3	649.7	793.7	2436.4	811.8	820.7	838.0	811.6	769.6	1258.2	930.3	1013.6	1020.6	965.9	816.9	816.4	803.4	903.1	789.0	778.7
37	*Sansevieria trifasciata* 'Hahnii'	283.5	298.2	347.9	298.2	313.4	367.0	289.6	499.7	282.3	582.9	498.2	642.7	572.1	725.7	623.0	657.6	691.4	745.2	777.0	690.6	849.0	715.7	854.4	731.3
38	*Sansevieria trifasciata* 'Laurentii'	740.4	474.5	1158.7	474.5	1301.3	568.5	1699.8	564.9	1880.4	569.4	1894.4	675.0	1927.6	682.8	1900.9	666.9	1801.2	641.9	1741.8	562.4	1902.3	393.0	2187.4	545.8
39	*Zamioculcas zamiifolia*	93.5	146.3	94.4	146.3	81.1	164.9	113.5	164.9	132.3	266.6	132.3	255.7	320.0	256.7	309.2	192.6	226.7	339.0	288.4	170.3	290.1	197.4	234.5	122.4
CD (0.05)	*Species*	7.39**		6.23**		9.33**		7.53**		4.92**		5.37**		6.74**		6.20**		7.73**		7.84**		7.03**		639.09	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS	
	Species x Systems	NS**		NS**		NS**		10.65**		6.96**		7.59**		9.54**		8.77**		10.93**		NS**		9.95**		903.81	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	506.2	883.6	911.3	883.6	782.3	1301.2	873.9	1237.6	1041.0	707.3	1258.7	799.2	1321.0	1073.0	1434.2	967.8	1431.6	1142.0	728.2	1302.1	520.9	1172.9	566.1	1237.7
41	*Cyperus alternifolius*	3312.0	3022.0	3610.4	3052.4	2644.9	2724.8	3452.4	4544.9	2947.2	4747.5	3784.6	4690.9	4760.6	4841.3	5235.6	5772.4	5742.6	6336.7	6457.6	6209.5	6387.2	8202.4	7356.3	7171.0
42	*Ophiopogon jaburan*	3155.2	3192.1	3594.7	3192.1	3358.1	3353.1	3153.3	3438.0	3936.1	4732.8	4435.9	4461.8	4588.4	4742.0	4572.3	4930.2	5290.9	5184.4	5174.4	5060.3	5729.2	5034.3	5668.3	3466.3
43	*Ophiopogon jaburan* 'Variegata'	2465.9	2237.9	2850.3	2237.9	2853.6	2783.1	3050.3	3154.9	3276.0	3586.3	3232.1	3892.8	3472.7	3866.9	3852.2	4146.8	3638.5	4238.3	3938.8	4167.8	4198.4	4227.0	4114.0	4402.4
44	*Scirpus cernuus*	1029.0	1006.3	1108.7	1006.3	548.6	1667.5	1188.9	1859.0	1552.3	1929.0	1582.1	2417.0	1596.3	2721.8	1975.3	2658.0	2016.1	2670.9	2113.7	2846.3	2296.6	2907.5	2503.5	2945.1
CD (0.05)	*Species*	444.31		397.88		588.27		666.56		829.24		797.31		1141.52		1035.51		1511.88		1092.88		1380.06		1251.81	
	Systems	NS		251.64		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
	Species x Systems	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	
	Climbing & Trailing*																								
45	*Asparagus setaceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	*Philodendron* 'Ceylon Gold'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	*Philodendron elegans*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	*Scindapsus aureus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	*Syngonium podophyllum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	*Syngonium wendlandii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants which spread was not observed because of their growth pattern

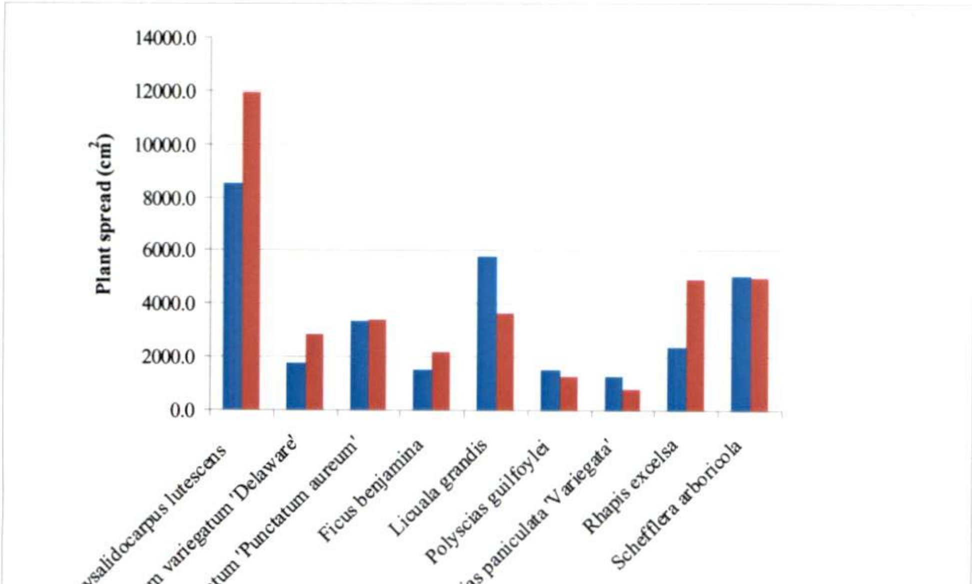
**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level



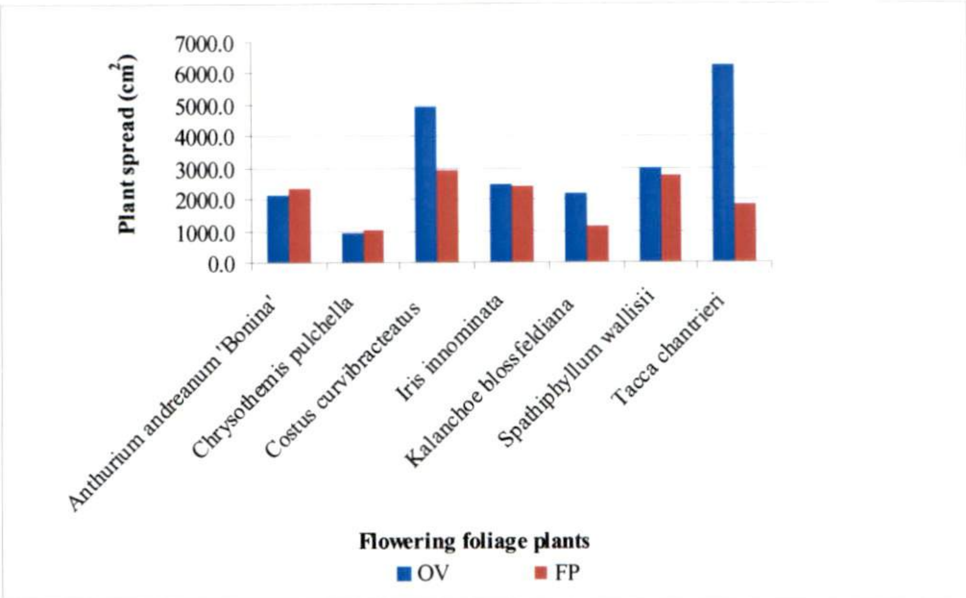
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 1. Spread of rosette type foliage plants in open ventilated and fan and pad greenhouse



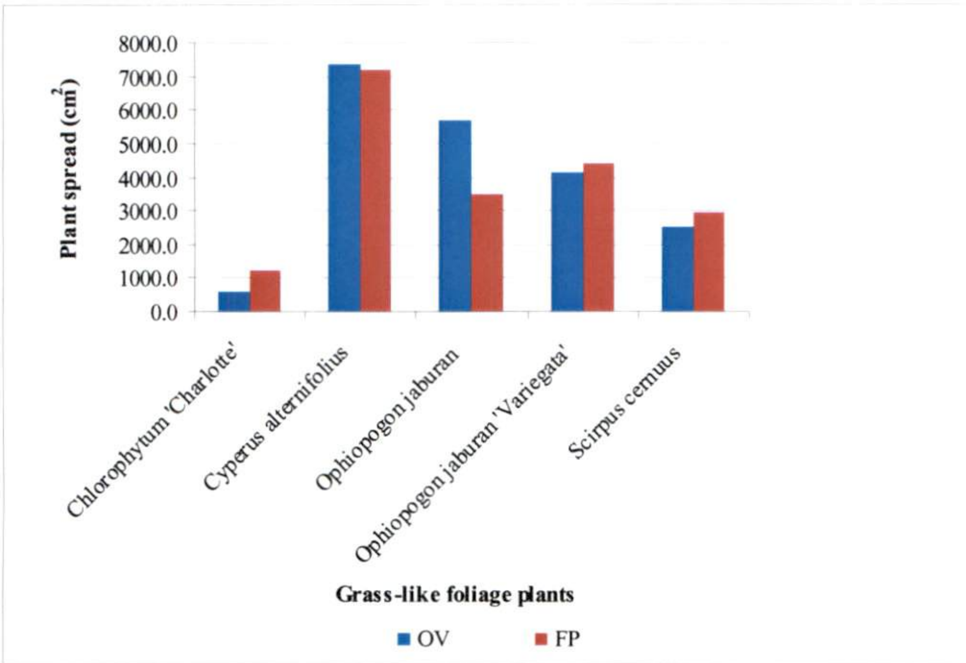
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 2. Spread of tree-like foliage plants in open ventilated and fan and pad greenhouses



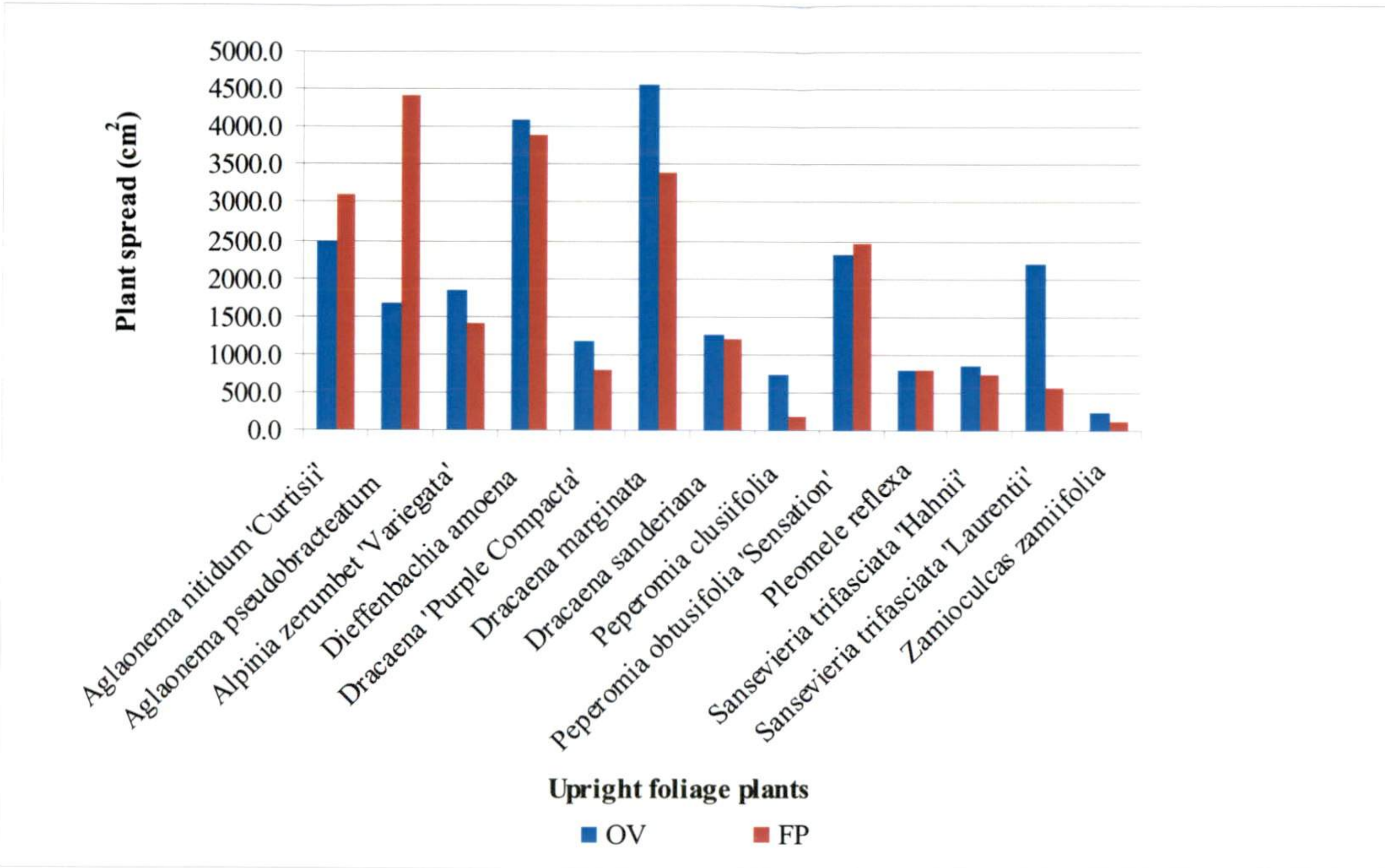
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 3. Spread of flowering foliage plants in open ventilated and fan and pad greenhouses



OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 4. Spread of grass-like foliage plants in open ventilated and fan and pad greenhouses



OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 5. Spread of upright foliage plants in open ventilated and fan and pad greenhouses

4.1.1.1.3. Length and breadth of leaves (cm)

When the foliage plants are concerned for interior plantscaping, the leaf characters are needed to be studied completely, so as to recommend them for particular conditions. Length and breadth of leaves are the important parameters to be considered while evaluating a foliage plant. In the present study, they were measured throughout the year at monthly intervals and the results are presented in Tables 4 & 5.

4.1.1.1.3.1. Leaf length (cm)

Among the rosette plants, the longest and the shortest leaves were observed in *Tillandsia stricta* and *Begonia rex* respectively. *Anthurium crystallinum* also had longer leaves and it was on par with the longest value mostly during the initial periods. There was no significant difference between the growing systems throughout the year except during sixth month when in OV plants had lengthier leaves than in FP. The interaction produced significant results only during later stages, in particular during the twelfth month, *Tillandsia stricta* in FP had the longest length of 61.4 cm and it was on par with *Anthurium crystallinum* in OV which had 57.7 cm length of leaves. The lowest was recorded in *Begonia rex* in both OV and FP where it had 7.2 and 8.3 cm long leaves respectively.

Chrysalidocarpus lutescens and *Ficus benjamina* were the species among tree-like plants, that had the longest and the shortest leaves respectively throughout the year. The shortest leaf length was on par with that of *Schefflera arboricola* and *Polyscias guilfoylei* during different months of observation. Among the growing systems, OV stayed ahead of FP during initial months and it was the opposite during the later months. Due to interaction effects, the significant difference among the combinations was observed only during few months. In particular, during the last month, *Chrysalidocarpus lutescens* in FP (123.6 cm) had the lengthiest leaves and the shortest length was observed in *Schefflera arboricola* in FP (6.8 cm) and *Ficus benjamina* in OV (7.0 cm) and in FP (6.2 cm).

In flowering plants, *Iris innominata* and *Kalanchoe blossfeldiana* recorded the longest and the shortest leaf length respectively. *Chrysothemis pulchella* and *Costus curvibracteatus* were on par with the shortest length during the middle of the year. Significantly different result was obtained between the growing systems only during fifth and ninth months when FP exceeded OV during the first and it was the opposite during the next month. Among the combinations, significantly different results were obtained only during the initial few months.

Table 4: Leaf length of foliage plants in two growing systems in different months

S. No.	Plant species	Leaf length (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	38.5	27.9	37.2	27.9	34.4	29.5	35.2	27.8	37.9	35.8	45.0	34.4	42.0	45.8	47.6	37.8	39.1	45.8	41.2	38.7	47.5	38.4	57.7	43.4
2	*Begonia rex*	7.7	9.7	10.9	9.0	10.2	9.6	10.8	9.1	8.3	6.8	8.8	7.0	9.2	7.9	8.7	8.2	7.2	8.3	10.7	8.0	8.7	9.0	7.2	8.3
3	*Calathea ornata* 'Roseo-lineata'	22.7	15.7	23.9	18.8	20.7	23.4	24.1	18.1	25.7	24.7	24.5	17.8	22.9	28.1	30.5	25.6	30.6	29.5	28.5	30.6	32.2	27.4	29.6	28.3
4	*Calathea zebrina*	17.3	16.0	13.8	16.7	18.6	19.7	14.4	19.6	16.0	17.0	18.0	18.1	18.5	17.3	17.9	20.4	27.2	21.8	17.2	21.0	17.2	18.5	19.3	21.0
5	*Homalomena wallisii*	17.7	24.5	19.0	19.8	21.7	21.7	23.7	25.3	25.0	23.8	25.9	20.8	21.8	20.7	22.9	28.0	20.3	19.2	20.7	25.4	23.0	19.6	26.2	21.2
6	*Philodendron wendlandii*	21.0	22.9	28.2	21.8	23.8	21.8	26.3	26.9	23.6	29.4	23.7	21.6	22.3	19.5	30.6	34.8	25.2	29.3	37.8	33.2	33.3	30.1	33.6	27.3
7	*Rhoeo discolor*	13.4	16.0	11.4	15.6	17.4	17.5	13.2	16.9	11.3	17.8	16.6	13.2	14.6	22.3	17.0	15.8	17.0	17.8	17.2	18.0	16.6	12.3	12.6	13.2
8	*Tillandsia stricta*	23.6	30.5	31.6	30.4	35.6	32.3	33.8	33.0	40.0	38.7	40.8	46.6	42.9	37.0	48.1	52.4	36.0	48.5	45.4	59.0	39.7	58.5	43.1	61.4
9	*Tradescantia spathacea* 'Sitara'	15.0	16.9	15.0	16.8	13.1	11.8	14.7	16.0	15.6	18.0	18.7	16.4	18.7	17.0	19.8	17.6	19.1	18.1	17.6	17.9	15.0	14.0	12.2	17.1
CD (0.05)	*Species*	0.49**		0.43**		0.58**		0.37**		0.51**		0.48**		0.52**		0.33**		0.41**		0.36**		0.39**		0.26**	
	Systems	NS**		NS**		NS**		NS**		NS**		0.22**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.55**		0.37**	
	Tree like																								
10	*Chrysalidocarpus lutescens*	120.0	51.7	112.0	84.7	99.3	83.1	88.2	92.0	76.8	89.5	94.2	97.7	93.8	91.1	95.2	114.9	90.6	103.3	127.3	114.5	98.6	104.4	105.5	123.6
11	*Codiaeum variegatum* 'Delaware'	14.9	11.3	17.4	12.5	19.6	17.6	16.3	24.2	17.7	21.4	21.2	16.9	12.8	28.8	25.5	24.3	20.2	23.8	19.0	24.5	19.9	23.6	20.1	21.6
12	*Codiaeum variegatum* 'Punctatum aureum'	13.0	12.0	13.4	11.7	13.5	15.7	15.4	18.9	16.9	20.8	18.4	17.6	14.3	12.2	19.0	18.1	16.9	20.9	19.5	24.2	15.7	21.0	13.3	21.2
13	*Ficus benjamina*	6.7	6.1	7.3	6.5	7.6	6.3	7.2	6.0	6.6	6.0	6.9	5.8	6.1	6.2	6.7	8.0	6.5	5.8	6.4	7.3	7.3	7.4	7.0	6.2
14	*Licuala grandis*	33.0	30.5	29.8	31.5	35.4	35.0	33.0	33.1	33.5	25.6	32.6	37.5	30.2	33.9	35.9	34.8	32.3	33.6	32.6	35.2	33.8	28.5	35.7	32.6
15	*Polyscias guilfoylei*	5.6	9.1	9.8	8.4	9.2	9.2	8.6	11.3	10.2	10.7	9.1	9.7	10.6	11.2	12.2	12.3	12.3	9.4	12.9	11.4	10.5	14.4	11.8	16.0
16	*Polyscias paniculata* 'Variegata'	10.8	16.5	16.5	18.9	18.4	19.3	17.7	15.6	22.9	13.2	21.8	19.4	25.6	18.7	15.9	23.8	22.9	20.9	24.7	13.9	15.9	18.2	18.6	17.5
17	*Rhapis excelsa*	18.0	17.9	16.4	19.6	16.3	20.9	17.6	21.9	14.0	29.2	18.3	23.6	16.0	28.7	22.0	30.3	15.7	28.6	18.4	32.9	19.2	23.2	19.2	25.6
18	*Schefflera arboricola*	9.5	9.9	9.0	8.1	10.9	8.3	9.0	8.6	10.8	7.8	9.6	7.2	9.5	8.6	9.3	9.2	9.4	9.3	9.3	9.1	9.1	5.7	10.2	6.8
CD (0.05)	*Species*	0.29**		0.4**		0.38**		0.52**		0.68**		0.42**		0.4**		0.43**		0.32**		0.34**		0.37**		0.24**	
	Systems	0.13**		0.18**		NS**		NS**		NS**		NS**		0.19**		0.2**		0.15**		NS**		NS**		0.11**	
	Species x Systems	0.41**		0.56**		NS**		NS**		0.96**		NS**		0.57**		NS**		0.46**		0.49**		NS**		0.34**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	14.7	16.6	14.2	17.4	15.4	18.0	18.0	19.2	17.6	21.4	19.8	26.5	19.4	24.8	25.2	24.7	27.9	24.4	19.6	26.5	23.9	27.3	21.3	25.8
20	*Chrysothemis pulchella*	11.7	14.3	8.9	23.0	12.1	15.2	16.2	20.2	14.9	11.7	12.1	13.2	13.1	16.2	14.3	14.9	14.2	12.4	18.4	11.0	14.8	16.0	10.7	13.6
21	*Costus curvibracteatus*	14.4	14.8	16.7	15.0	17.8	18.3	16.8	18.6	13.3	16.8	17.0	16.4	14.9	12.1	17.9	19.1	15.4	15.6	15.7	15.4	13.7	18.5	15.7	16.7
22	*Iris innominata*	44.0	45.8	45.6	41.2	41.4	41.8	48.8	56.7	47.8	54.7	57.9	60.8	49.2	55.0	51.1	51.1	62.8	51.8	45.5	50.3	54.1	48.3	54.3	51.7
23	*Kalanchoe blossfeldiana*	5.6	7.7	5.6	8.0	5.7	8.3	8.4	9.4	9.6	9.7	10.5	11.8	15.3	9.3	12.0	11.5	10.1	8.2	11.8	10.0	10.1	9.2	9.0	8.8
24	*Spathiphyllum wallisii*	21.5	19.4	23.8	18.9	21.8	19.4	21.5	25.1	22.4	24.3	21.9	26.1	24.0	25.8	25.9	26.1	24.3	25.1	23.9	27.1	23.6	19.3	24.5	17.8
25	*Tacca chantrieri*	24.2	22.9	30.1	23.0	29.7	20.1	30.7	27.3	26.9	34.0	33.1	27.0	35.2	29.2	33.7	32.2	29.3	28.7	33.0	29.1	31.9	23.4	27.4	21.8
CD (0.05)	*Species*	0.36**		0.4**		0.36**		0.39**		0.38**		0.32**		0.34**		0.43**		0.31**		0.34**		0.35**		0.26**	
	Systems	NS**		NS**		NS**		NS**		0.2**		NS**		NS**		NS**		0.16**		NS**		NS**		NS**	
	Species x Systems	NS**		0.56**		NS**		NS**		NS**		0.49**		0.49**		NS**		NS**		0.48**		0.49**		0.37**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 4: Leaf length of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Leaf length (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	23.0	24.4	22.3	28.6	26.0	23.4	30.3	32.9	30.9	29.0	31.0	26.8	26.2	24.3	27.0	30.0	26.7	26.7	23.5	29.2	26.4	29.2	31.3	29.9
27	*Aglaonema pseudobracteatum*	22.7	26.8	25.5	26.1	25.8	27.3	25.5	29.8	27.1	27.3	26.9	24.8	23.2	24.5	22.9	31.2	22.2	29.2	24.3	24.4	27.1	28.0	25.4	26.4
28	*Alpinia zerumbet* 'Variegata'	24.5	23.6	25.9	25.0	27.9	23.7	30.7	23.5	27.9	19.6	30.8	27.7	27.3	25.8	29.5	30.6	27.6	33.9	32.0	33.3	34.7	28.8	32.1	32.6
29	*Dieffenbachia amoena*	31.2	32.0	30.7	31.9	34.1	33.2	32.2	30.6	35.5	32.0	35.3	30.5	33.8	33.4	33.6	33.6	37.2	31.2	32.1	33.8	30.5	33.4	34.1	34.8
30	*Dracaena* 'Purple Compacta'	10.7	12.5	11.6	12.8	11.5	13.4	12.3	13.5	11.9	13.8	11.5	12.4	12.8	13.7	13.0	12.7	12.8	12.4	11.9	13.7	11.2	11.7	10.9	12.1
31	*Dracaena marginata*	36.0	34.1	35.2	36.7	38.8	37.7	37.4	34.9	40.3	36.8	35.8	32.4	38.1	33.5	39.0	44.8	43.0	39.1	46.4	39.4	37.4	39.7	40.1	41.6
32	*Dracaena sanderiana*	10.3	12.2	12.1	13.2	14.8	13.4	12.2	12.3	13.5	17.1	17.5	17.8	15.5	18.4	20.3	18.0	16.3	17.1	18.5	18.0	19.3	17.5	21.2	18.2
33	*Nephrolepis exaltata*	54.5	46.4	78.8	58.8	84.4	88.8	102.0	82.4	80.4	93.6	94.8	95.2	68.0	106.4	142.4	100.4	94.8	92.8	94.8	94.4	94.0	87.6	110.8	81.6
34	*Peperomia clusiifolia*	8.4	8.9	9.3	7.7	8.5	7.3	9.4	6.2	9.9	6.0	10.6	8.4	8.7	7.5	10.4	9.7	9.7	11.6	8.8	7.2	11.8	8.8	11.9	7.8
35	*Peperomia obtusifolia* 'Sensation'	7.6	7.6	6.8	7.5	7.0	7.7	6.7	8.0	6.8	7.8	7.4	8.3	6.2	7.7	7.9	7.9	8.1	8.9	9.2	8.0	9.9	8.6	7.2	8.2
36	*Pleomele reflexa*	14.9	14.6	17.3	13.8	14.9	16.1	14.0	16.5	15.8	14.1	16.5	15.6	16.4	15.5	13.6	17.1	15.2	18.6	13.1	15.8	14.2	14.2	14.0	15.1
37	*Sansevieria trifasciata* 'Hahnii'	13.1	11.7	11.5	11.2	13.2	12.0	11.8	11.5	12.2	16.0	12.0	16.0	10.6	19.8	11.9	15.0	18.3	17.5	14.9	18.4	18.1	14.2	13.6	13.3
38	*Sansevieria trifasciata* 'Laurentii'	43.3	62.6	53.8	51.3	36.2	67.0	48.1	49.3	57.6	70.5	57.1	73.3	56.0	77.5	65.9	54.0	64.1	51.9	51.2	52.7	60.7	58.5	57.9	63.8
39	*Zamioculcas zamiifolia*	5.3	6.2	5.6	5.4	5.9	6.7	4.7	6.4	5.3	7.4	6.6	8.1	6.3	6.0	7.0	8.1	6.3	6.2	9.4	7.1	10.3	7.1	8.2	6.8
CD (0.05)	*Species*	0.36**		0.42**		0.42**		0.34**		0.36**		0.27**		0.43**		0.3**		0.32**		0.35**		0.28**		0.25**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		0.16**		NS**		NS**		NS**		0.1**		0.09**	
	Species x Systems	0.51**		NS**		0.59**		0.48**		0.51**		0.38**		0.62**		0.42**		0.46**		NS**		NS**		0.35**	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	15.0	14.7	15.2	17.1	15.6	16.6	16.8	16.2	17.2	16.0	16.2	18.9	15.9	15.4	18.4	20.9	19.0	18.9	15.6	18.2	12.9	15.5	12.5	17.2
41	*Cyperus alternifolius*	37.6	41.8	37.0	39.5	32.2	37.5	35.6	44.7	31.3	46.3	57.8	49.6	51.2	51.2	48.0	51.0	54.9	47.2	52.9	51.1	46.7	49.5	51.3	51.0
42	*Ophiopogon jaburan*	31.3	38.4	41.9	36.9	43.8	38.6	50.0	41.3	47.9	40.9	64.9	44.4	47.7	55.6	60.7	59.9	46.0	41.9	44.9	67.5	51.5	49.7	45.7	47.2
43	*Ophiopogon jaburan* 'Variegata'	30.7	33.7	36.6	38.7	38.8	44.1	34.8	40.9	37.7	52.5	39.0	47.2	39.5	49.0	36.6	39.6	49.1	34.7	41.4	58.0	43.0	29.4	36.8	35.1
44	*Scirpus cernuus*	15.8	17.9	18.0	20.3	17.2	22.4	18.5	25.1	20.7	27.1	16.6	25.7	19.5	28.7	19.2	26.3	24.7	23.7	23.2	29.4	21.9	24.8	22.9	26.2
CD (0.05)	*Species*	3.01		4.35		4.83		4.68		5.22		5.44		6.53		3.93		4.51		4.62		3.50		3.63	
	Systems	1.90		NS		NS		NS		3.30		NS		NS		NS		2.85		2.92		NS		NS	
	Species x Systems	NS		NS		NS		NS		7.38		7.70		NS		NS		NS		6.53		4.95		NS	
	Climbing & Trailing																								
45	*Asparagus setaceus*	15.2	15.8	15.2	6.4	20.8	20.0	8.4	15.9	14.6	10.7	13.2	16.8	14.2	16.7	21.3	14.1	18.1	16.0	18.3	19.2	17.1	14.5	18.4	13.2
46	*Philodendron* 'Ceylon Gold'	18.0	22.9	16.7	23.5	20.3	24.3	20.6	25.9	24.9	19.3	27.1	23.2	23.2	23.9	29.4	28.3	25.6	29.9	32.0	28.7	30.4	26.0	29.8	24.8
47	*Philodendron elegans*	21.9	24.4	27.9	20.7	19.8	21.6	25.4	29.4	23.1	28.0	34.2	20.4	28.8	26.9	22.4	23.1	24.6	24.4	30.5	28.9	23.8	21.2	28.7	24.4
48	*Scindapsus aureus*	8.0	8.6	8.4	8.1	8.9	10.3	9.4	9.8	12.3	9.1	12.5	10.8	11.6	11.8	12.5	10.7	12.5	9.3	10.2	8.2	9.6	17.3	8.9	11.6
49	*Syngonium podophyllum*	7.5	13.1	10.0	15.3	12.0	16.0	11.8	16.6	13.5	17.8	19.8	16.6	10.6	16.3	10.0	17.9	17.0	16.9	17.8	18.7	16.0	18.5	15.6	19.3
50	*Syngonium wendlandii*	12.8	11.7	14.8	13.3	14.1	14.2	11.7	10.5	9.7	14.3	15.2	12.4	16.2	12.0	16.6	17.5	12.3	13.4	14.9	13.6	18.7	14.3	11.6	16.2
CD (0.05)	*Species*	0.54**		0.41**		0.42**		0.44**		0.39**		0.47**		0.56**		0.46**		0.42**		0.37**		0.32**		0.27**	
	Systems	NS**		NS**		NS**		0.25**		NS**		0.27**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		0.58**		NS**		NS**		0.56**		NS**		NS**		NS**		NS**		NS**		0.45**		0.39**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

During the last month, *Iris innominata* in OV (54.3 cm) as well as in FP (51.7 cm) had the maximum leaf lengths, whereas *Kalanchoe blossfeldiana* in OV (9 cm) as well as in FP (8.8 cm) had the minimum and this was on par with *Chrysothemis pulchella* in OV (10.7 cm).

Among the upright plants, the lengthiest and the shortest leaf lengths were recorded in *Nephrolepis exaltata* and *Zamioculcas zamiifolia* respectively. Leaf length of *Sansevieria trifasciata* 'Laurentii' was on par with the lengthiest value during the first month whereas *Peperomia clusiifolia* and *Peperomia obtusifolia* 'Sensation' were on par with the shortest. OV was found to have lengthier leaves than FP during the months of 11th and 12th whereas during 7th month it was just the opposite. Due to interaction effects, there was a fluctuation among the combinations. However during the last month, *Nephrolepis exaltata* had the maximum leaf length of 110.8 cm in OV and *Peperomia clusiifolia,* the minimum in FP (7.8 cm). *Peperomia obtusifolia* 'Sensation' and *Zamioculcas zamiifolia* had the minimum values irrespective of the systems.

Among the grass-like plants, *Cyperus alternifolius* and *Ophiopogon jaburan* were the species that had the lengthiest leaves in most of the months and *Chlorophytum* 'Charlotte' with the shortest leaves throughout the year. In FP they had lengthier leaves than OV in all the months except during 9th month when it was more in OV. Among the combinations, significant difference was observed only during few months which were more significant during the eleventh month. *Cyperus alternifolius* and *Ophiopogon jaburan* in both systems OV (51.3 and 45.7 cm) and FP (51 and 47.2 cm) had the maximum length respectively. The minimum length was observed in *Chlorophytum* 'Charlotte' in OV (12.5 cm) as well as in FP (17.2 cm).

In climbing & trailing type, *Philodendron* 'Ceylon Gold' and *Philodendron elegans* were the species that had the lengthiest leaves in most of the months and *Scindapsus aureus* had the shortest leaves throughout the year. The growing systems significantly differed only during the fourth and sixth months. The interaction also produced significant difference among the combinations only during few months, especially during the last month, *Philodendron* 'Ceylon Gold' (29.8 cm) and *Philodendron elegans* (28.7 cm) had the lengthiest leaves whereas *Scindapsus aureus* (8.9 cm) in OV had the shortest during the last month.

4.1.1.1.3.2. Leaf breadth (cm)

Among the rosette type, the broadest and the narrowest leaves were observed in *Anthurium crystallinum* and *Tillandsia stricta* respectively. Significantly different result was obtained between the growing systems only during few months when OV exceeded FP. The interactions had shown significant difference only during 9th and the last months. During the last month, *Anthurium crystallinum* had the maximum leaf breadth of 34.2 cm in OV. *Tillandsia stricta* in OV (1.2 cm) as well as in FP (1.5 cm) and *Tradescantia spathacea* 'Sitara' (1.7 cm) in OV had the least leaf breadth.

Chrysalidocarpus lutescens and *Codiaeum variegatum* 'Punctatum aureum' were the species among tree-like plants had the broadest and the narrowest leaves throughout the year. OV exceeded FP during 10th and 11th months, whereas during the 8th month it was just the opposite. The combinations had more significant results only during later stages. During the last month, *Chrysalidocarpus lutescens* in FP (82.4 cm) and *Codiaeum variegatum* 'Punctatum aureum' in OV (1.9 cm) and FP (1.1 cm) were the best and the least respectively.

Among the flowering plants, during the initial periods, the maximum leaf breadth was observed in *Tacca chantrieri*, but during the last month, it was in *Anthurium andreanum* 'Bonina'. The narrowest leaf was observed in *Iris innominata*. During the 9th month, the growing systems differed significantly among them when OV topped the other. The interaction effect was significant only during few months. During the year end, *Tacca chantrieri* in OV (11.5 cm) and *Anthurium andreanum* 'Bonina' in both systems OV (10.8) and FP (12.6 cm) had the maximum leaf breadth and *Chrysothemis pulchella* in OV (4.1 cm) and *Iris innominata* in OV (4 cm) and FP (3.4 cm) the least.

In upright plants, the broadest leaf was observed in *Dieffenbachia amoena* and it was on par with *Nephrolepis exaltata* during the later months. The narrowest was observed in *Pleomele reflexa* which was on par with *Dracaena marginata* and *Zamioculcas zamiifolia* during the middle of the year. Significant difference among growing systems was observed only during the period between 7th and 9th months when FP over performed the other. Among the combinations, during the last month, *Dieffenbachia amoena* (17.2 cm) in FP and *Nephrolepis exaltata* (18.5 cm) in OV were the best having the maximum leaf breadth whereas *Dracaena marginata* in OV (2.7 cm) and *Pleomele reflexa* in both systems OV (2.4 cm) and FP (2.2 cm) had the minimum.

Table 5: Leaf breadth of foliage plants in two growing systems in different months

S. No.	Plant species	Leaf breadth (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	26.0	18.0	24.4	18.5	22.8	18.8	22.6	18.8	24.7	28.6	29.0	22.8	27.8	32.2	28.3	24.2	24.6	29.7	27.3	29.7	31.2	26.0	34.2	31.3
2	*Begonia rex*	8.4	8.1	8.9	7.3	9.0	7.6	7.4	7.4	7.3	5.2	7.3	5.7	7.0	5.8	6.3	6.3	5.6	6.2	7.6	6.7	6.6	6.7	5.6	5.8
3	*Calathea ornata* 'Roseo-lineata'	9.4	8.1	9.8	8.3	7.2	7.3	9.8	7.5	9.8	9.7	7.7	6.1	7.9	10.1	10.5	8.9	11.2	8.5	12.1	10.5	8.2	8.7	9.6	8.9
4	*Calathea zebrina*	8.8	8.1	7.0	8.2	9.3	9.1	7.3	8.6	8.4	8.1	9.2	8.0	8.1	8.2	8.1	8.1	11.5	8.4	7.8	8.1	8.0	8.8	8.7	7.9
5	*Homalomena wallisii*	8.4	11.1	9.3	9.3	10.1	9.7	10.5	11.1	11.4	9.6	11.1	8.6	8.9	9.0	10.4	10.8	8.8	8.5	9.6	10.4	9.2	8.7	11.2	8.3
6	*Philodendron wendlandii*	6.1	7.3	10.1	6.8	8.1	6.7	8.1	7.4	7.8	8.4	6.9	7.2	6.9	6.3	10.4	9.8	7.3	8.3	12.7	12.8	11.4	8.7	10.8	8.5
7	*Rhoeo discolor*	2.3	2.5	2.0	2.4	2.5	2.6	2.3	2.4	2.2	2.5	2.3	2.2	2.6	3.2	2.6	2.5	2.8	2.6	2.4	2.5	2.2	2.2	2.4	2.3
8	*Tillandsia stricta*	1.0	1.2	1.2	1.3	1.2	1.3	1.2	1.3	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.1	1.3	1.2	1.4	1.2	1.5	1.2	1.5
9	*Tradescantia spathacea* 'Sitara'	2.2	2.5	2.2	2.4	2.0	2.3	1.6	1.8	2.0	2.7	1.9	2.4	1.9	2.9	2.7	2.6	2.7	2.2	2.5	2.5	2.0	2.3	1.7	2.4
CD (0.05)	***Species***	0.32**		0.25**		0.34**		0.25**		0.36**		0.23**		0.4**		0.23**		0.22**		0.23**		0.31**		0.16**	
	Systems	NS**		0.11**		NS**		NS**		NS**		0.11**		NS**		NS**		NS**		NS**		NS**		0.07**	
	Species* x *Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.32**		NS**		NS**		0.23**	
	Tree like																								
10	*Chrysalidocarpus lutescens*	45.6	41.0	26.2	56.5	66.2	55.4	58.8	61.3	51.2	59.7	62.8	65.1	62.5	60.7	63.5	76.6	60.4	68.9	84.9	76.3	65.7	69.6	70.3	82.4
11	*Codiaeum variegatum* 'Delaware'	5.9	4.0	7.4	4.7	5.9	7.1	5.7	7.4	6.4	7.8	7.9	5.9	5.4	8.6	8.5	8.0	7.6	8.4	6.5	8.0	6.3	8.2	6.6	7.8
12	*Codiaeum variegatum* 'Punctatum aureum'	0.9	0.8	0.9	0.9	0.8	1.0	1 0	1.1	1.1	1.2	1.2	1.1	0.8	1.1	1.0	0.9	1.1	1.0	0.9	1.3	0.9	1.2	1.9	1.1
13	*Ficus benjamina*	3.0	2.5	3.4	3.0	3.6	2.9	3.4	2.7	3.0	2.4	3.1	2.7	2.6	2.9	2.9	3.7	2.9	2.8	3.0	3.0	3.0	3.0	3.1	2.7
14	*Licuala grandis*	9.9	11.4	12.2	14.5	7.6	8.2	15.3	7.8	13.3	18.9	23.9	21.9	25.9	26.4	32.5	30.5	27.2	26.5	22.8	29.9	27.9	21.5	23.4	23.7
15	*Polyscias guilfoylei*	5.1	5.7	6.1	5.3	5.7	5.7	5.4	7.1	6.4	6.7	5.7	6.1	6.6	7.0	7.6	7.7	7.7	5.9	8.1	7.1	6.5	9.0	7.4	10.0
16	*Polyscias paniculata* 'Variegata'	10.1	9.4	9.4	10.8	10.5	11.0	10.1	8.9	13.1	7.5	12.5	11.1	14.6	10.7	9.1	13.6	13.1	11.9	14.1	7.9	9.1	10.4	10.6	10.0
17	*Rhapis excelsa*	23.7	26.5	24.4	15.1	17.2	12.3	23.3	13.6	23.5	18.9	21.7	18.3	18.9	20.4	14.5	17.9	22.0	23.3	34.9	15.3	39.9	18.4	23.6	20.0
18	*Schefflera arboricola*	18.4	16.8	17.2	15.4	13.0	15.6	14.0	20.0	16.4	19.6	14.4	16.8	18.6	20.4	15.8	20.8	18.4	19.6	18.8	20.8	20.8	16.8	25.4	18.0
CD (0.05)	***Species***	0.51**		0.41**		0.3**		0.52**		0.65**		0.48**		0.34**		0.38**		0.29**		0.29**		0.31**		0.25**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.18**		NS**		0.13**		0.14**		NS**	
	Species* x *Systems	NS**		0.59**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.41**		0.44**		0.35**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	8.2	9.3	7.7	9.3	8.5	8.2	9.5	8.9	8.9	11.0	10.0	11.2	10.1	10.3	11.9	10.7	14.2	12.2	8.9	11.5	10.3	13.5	10.8	12.6
20	*Chrysothemis pulchella*	4.9	6.2	4.1	9.6	5.5	7.0	7.0	8.4	6.3	5.2	6.1	5.7	6.7	7.3	6.1	5.4	5.6	5.0	6.8	7.4	7.8	8.7	4.1	7.5
21	*Costus curvibracteatus*	7.3	6.5	7.4	6.6	7.8	6.8	7.9	6.5	6.0	7.4	6.6	6.2	6.1	5.0	6.7	7.3	6.1	6.3	6.6	6.1	6.4	7.2	6.9	7.1
22	*Iris innominata*	3.9	3.9	3.9	3.2	4.1	3.4	4.1	4.0	3.7	4.2	3.9	3.7	3.7	3.9	3.8	3.9	4.1	3.3	3.3	3.8	4.0	3.3	4.0	3.4
23	*Kalanchoe blossfeldiana*	4.3	5.6	4.4	6.0	3.8	6.2	6.2	7.7	7.9	6.7	8.1	9.6	7.0	6.8	8.1	9.4	6.9	7.0	7.8	7.6	6.2	6.8	6.2	6.5
24	*Spathiphyllum wallisii*	8.5	7.1	9.3	7.1	8.1	6.6	7.7	7.9	7.9	8.2	7.2	8.4	7.5	7.7	11.4	9.8	8.0	7.4	8.1	7.8	8.0	9.8	9.5	7.4
25	*Tacca chantrieri*	9.5	9.5	12.9	9.1	12.3	8.9	12.3	11.0	11.7	14.1	14.4	10.7	16.2	12.6	15.2	14.6	13.1	10.8	15.3	13.3	12.8	8.4	11.5	8.2
CD (0.05)	***Species***	0.27**		0.23**		0.19**		0.28**		0.24**		0.2**		0.22**		0.29**		0.21**		0.18**		0.23**		0.2**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.11**		NS**		NS**		NS**	
	Species* x *Systems	NS**		0.32**		0.28**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.33**		0.28**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 5: Leaf breadth of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Leaf breadth (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	8.6	9.5	8.5	10.4	9.3	9.2	10.3	13.9	11.9	11.2	11.8	11.2	10.9	8.3	8.4	12.6	10.0	10.2	9.4	11.6	10.2	10.3	11.2	10.2
27	*Aglaonema pseudobracteatum*	6.6	7.3	6.7	7.5	7.2	7.4	7.2	7.9	6.9	7.8	8.2	6.3	6.1	6.7	5.6	8.1	5.5	8.5	5.9	6.7	7.1	7.4	6.7	7.5
28	*Alpinia zerumbet* 'Variegata'	7.4	6.4	7.4	7.1	7.4	6.1	6.3	6.0	7.1	6.0	5.5	6.1	6.1	6.6	5.4	8.3	6.0	10.0	8.1	7.4	8.3	7.8	7.0	7.2
29	*Dieffenbachia amoena*	14.4	14.2	14.2	13.9	14.2	15.1	14.9	15.0	15.6	13.6	16.1	14.8	17.8	16.2	16.1	16.8	18.2	15.4	16.3	20.6	15.5	16.4	15.9	17.2
30	*Dracaena* 'Purple Compacta'	3.4	4.5	3.6	4.1	3.4	4.4	3.7	5.0	4.2	4.7	4.4	4.5	4.7	4.8	4.5	4.7	4.0	4.5	3.9	4.9	3.6	4.6	3.6	4.8
31	*Dracaena marginata*	2.5	1.9	2.4	2.2	2.8	2.6	2.3	2.2	2.9	2.2	2.0	2.5	1.9	2.6	3.2	3.3	3.4	2.8	3.5	2.8	2.6	3.0	2.7	3.1
32	*Dracaena sanderiana*	2.5	3.0	2.8	3.2	3.1	3.5	2.9	3.2	3.1	4.3	4.2	4.3	3.6	4.0	3.9	4.5	4.3	4.4	4.1	4.8	4.3	4.9	4.8	5.1
33	*Nephrolepis exaltata*	12.9	7.7	13.1	9.8	14.1	14.8	17.0	13.7	13.4	15.6	15.8	15.9	11.3	17.7	23.7	16.7	15.8	15.5	15.8	15.7	15.7	14.6	18.5	13.6
34	*Peperomia clusiifolia*	3.3	3.2	3.5	2.9	3.7	3.0	3.6	2.5	3.8	2.6	3.5	3.6	3.1	3.3	5.1	3.7	4.7	3.9	3.9	3.7	3.9	3.4	4.0	3.6
35	*Peperomia obtusifolia* 'Sensation'	4.9	5.3	4.8	5.6	4.8	5.4	4.8	5.2	4.7	5.9	5.5	6.0	4.9	5.7	5.2	5.6	5.0	6.4	6.2	6.0	6.6	6.2	5.4	5.8
36	*Pleomele reflexa*	2.1	2.0	2.4	2.2	2.1	2.4	2.3	2.3	2.5	2.4	2.4	2.3	2.5	2.5	2.2	2.4	2.4	2.4	2.3	2.4	2.0	2.4	2.4	2.2
37	*Sansevieria trifasciata* 'Hahnii'	6.2	5.7	6.3	5.7	5.7	5.0	5.5	6.2	5.9	6.3	5.7	6.3	6.1	6.3	6.4	5.9	6.9	7.5	6.7	6.8	7.9	5.7	6.3	5.2
38	*Sansevieria trifasciata* 'Laurentii'	4.8	6.0	5.9	6.9	6.8	6.3	5.5	6.5	5.9	7.2	5.0	6.9	6.1	7.1	5.8	5.2	6.1	6.9	6.2	4.8	6.2	7.8	5.6	7.5
39	*Zamioculcas zamiifolia*	2.1	2.7	2.3	2.3	2.1	3.0	2.1	2.7	2.5	3.0	2.7	3.0	2.4	2.9	2.8	3.1	2.9	3.1	3.9	4.3	3.9	4.4	4.5	4.2
CD (0.05)	*Species*	0.19**		0.22**		0.2**		0.19**		0.15**		0.16**		0.2**		0.13**		0.16**		0.18**		0.13**		0.11**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		0.07**		0.05**		0.06**		NS**		NS**		NS**	
	Species x *Systems*	0.27**		NS**		NS**		0.27**		0.22**		NS**		0.28**		0.19**		0.23**		0.25**		0.18**		0.16**	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	3.4	3.0	3.0	3.6	3.4	3.1	3.1	4.1	3.2	3.9	2.8	3.2	3.0	2.8	3.1	3.0	3.7	3.1	3.5	3.0	2.8	3.3	2.9	3.1
41	*Cyperus alternifolius*	38.2	38.0	33.7	35.9	29.3	34.1	32.4	40.6	28.5	42.1	52.5	45.1	46.5	46.5	43.6	46.4	49.9	42.9	48.1	46.5	42.5	45.0	46.6	46.4
42	*Ophiopogon jaburan*	1.1	1.0	1.1	1.0	1.0	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.1	0.9	0.9	0.9	0.9	0.8	1.0	0.6	1.0	0.9	1.0
43	*Ophiopogon jaburan* 'Variegata'	1.0	1.0	1.0	0.9	1.0	1.0	0.8	0.9	0.7	1.0	0.8	0.9	0.9	1.0	0.9	0.9	1.0	1.0	0.8	1.0	0.9	1.0	0.9	0.9
44	*Scirpus cernuus*	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
CD (0.05)	*Species*	0.18**		0.11**		0.2**		0.2**		0.15**		0.24**		0.25**		0.13**		0.23**		0.18**		0.17**		0.15**	
	Systems	NS**		NS**		NS**		0.12**		0.09**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x *Systems*	NS**		NS**		NS**		NS**		0.21**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Climbing & Trailing																								
45	*Asparagus setaceus*	11.6	13.2	11.6	2.6	12.2	8.9	5.9	12.6	11.0	6.5	11.9	13.7	12.0	11.8	15.7	10.8	14.7	14.2	14.6	17.1	14.9	7.5	17.1	6.4
46	*Philodendron* 'Ceylon Gold'	7.5	8.1	5.9	8.9	7.3	9.8	7.8	10.0	9.4	7.1	9.3	8.3	10.1	8.8	12.9	11.7	10.5	11.7	12.0	9.3	12.0	9.6	12.0	8.5
47	*Philodendron elegans*	18.9	17.1	24.3	16.1	16.1	17.0	21.0	20.7	18.7	22.5	26.6	17.2	22.2	21.7	19.4	18.2	20.9	20.0	19.5	22.3	18.9	18.2	24.5	21.2
48	*Scindapsus aureus*	7.8	6.4	7.0	6.2	7.7	7.1	7.8	6.1	9.9	7.1	9.6	6.9	9.7	7.6	8.9	8.4	7.3	7.1	7.9	6.9	5.9	11.0	6.9	7.2
49	*Syngonium podophyllum*	4.3	6.9	5.4	7.8	6.2	7.5	5.2	7.7	6.2	8.8	7.4	7.4	4.2	7.6	6.2	7.7	8.2	8.0	7.8	9.5	9.8	8.8	8.1	7.8
50	*Syngonium wendlandii*	5.0	4.3	4.4	4.4	3.8	4.3	3.9	3.8	5.3	4.0	14.5	4.3	6.4	4.3	5.4	9.4	4.5	4.8	4.5	4.0	4.8	4.5	3.8	4.7
CD (0.05)	*Species*	0.36**		0.31**		0.27**		0.35**		0.27**		0.32**		0.43**		0.31**		0.27**		0.25**		0.25**		0.19**	
	Systems	NS**		0.17**		NS**		0.2**		NS**		0.18**		NS**		NS**		NS**		NS**		NS**		0.11**	
	Species x *Systems*	NS**		0.44**		NS**		0.49**		0.38**		0.46**		NS**		0.44**		NS**		NS**		0.36**		0.28**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Among the grass-like plants, *Cyperus alternifolius* and *Scirpus cernuus* were the species with the broadest and the narrowest leaves respectively throughout the year. During 4th and 5th months, the plants kept in FP had broader leaves than OV. During 5th month, *Cyperus alternifolius* in FP recorded the maximum leaf breadth of 42.1 cm and *Scirpus cernuus* recorded 0.4 cm in both OV and FP was the minimum leaf breadth.

In climbing & trailing plants, *Philodendron elegans* and *Syngonium wendlandii* were the species that had the broadest and the narrowest leaves respectively. The growing systems differed significantly only during second, fourth and sixth months when OV excelled the other during the first and the last month; during the middle of the year it was the opposite. Among the significantly different combinations, during the year end, *Philodendron elegans* in OV (24.5 cm) and *Syngonium wendlandii* in both OV (3.8 cm) and FP (4.7 cm) were the maximum and the minimum respectively.

4.1.1.1.4. Leaf area (cm^2)

Leaf area is one of the main parameters that indicates the adaptability of plants to indoors. It was found that species differed significantly for this parameter. Leaf area of foliage plants was recorded monthly and presented in Table 6.

Leaf area of *Anthurium crystallinum* was found to be the maximum among rosette type of plants and *Rhoeo discolor*, *Tillandsia stricta* and *Tradescantia spathacea* 'Sitara' had the smallest leaves. All the other species were on par with the smallest in one or the other months. Among the growing systems, significantly different result was obtained only during 2nd, 6th and 12th months when the plants kept in OV had more leaf area than those in FP. *Anthurium crystallinum* had the maximum area in OV (1422.6 cm^2) and the minimum was 26 and 31.7 cm^2 in *Begonia rex*; 22.9 and 25.3 cm^2 in *Rhoeo discolor*; 38.9 and 7.7 cm^2 in *Tillandsia stricta* and; 11.4 and 24.5 cm^2 in *Tradescantia spathacea* 'Sitara' in both OV and FP respectively during the last month.

Among the tree-like plants, the maximum leaf area was recorded in *Chrysalidocarpus lutescens* throughout the year except in 8th and 9th months where *Licuala grandis* had the largest leaves and it was also on par with *C. lutescens* during 6th and 7th months. All the remaining species recorded smallest leaf area in one or the other months and they were on par with each other. FP was found to facilitate the plants for having large leaf area than OV during 4th, 5th, 10th and 12th months. The interaction effect had produced significantly

Table 6: Leaf area of foliage plants in two growing systems in different months

S. No.	Plant species	Leaf area (sq. cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	685.1	412.7	794.5	413.5	475.8	428.0	640.6	380.0	540.9	782.4	964.4	573.9	908.7	1077.4	972.2	671.2	697.2	983.4	813.1	823.9	1092.3	704.2	1422.6	978.1
2	*Begonia rex*	33.7	66.4	76.7	48.9	76.4	39.7	58.9	50.5	58.8	24.2	43.5	30.4	45.5	26.8	36.4	38.0	27.3	32.8	55.4	42.2	39.2	40.4	26.0	31.7
3	*Calathea ornata* 'Roseo-lineata'	169.7	109.6	253.0	105.9	128.0	151.0	183.7	103.0	185.4	156.7	141.8	89.8	131.0	193.1	242.6	212.6	274.0	237.3	247.8	223.6	238.1	184.7	214.8	193.5
4	*Calathea zebrina*	114.1	89.7	68.2	96.8	159.7	140.7	79.6	121.3	107.5	107.8	164.5	105.3	113.6	113.2	100.5	109.8	232.7	148.9	91.6	67.3	103.4	112.9	128.2	123.5
5	*Homalomena wallisii*	115.7	198.8	148.0	126.4	157.1	143.4	176.7	224.3	203.9	139.4	205.0	130.8	111.4	125.5	146.2	206.5	148.8	135.4	136.1	144.3	154.9	122.7	202.7	127.7
6	*Philodendron wendlandii*	117.6	116.0	259.7	122.8	223.1	94.7	152.3	139.9	128.5	140.2	115.8	90.6	100.1	69.3	192.4	192.4	113.3	150.2	277.2	244.6	235.0	191.7	205.3	173.6
7	*Rhoeo discolor*	27.1	28.7	16.0	25.0	38.1	25.6	18.8	28.6	19.4	37.2	27.3	23.7	27.8	49.5	28.2	30.4	35.3	39.7	32.6	25.7	26.1	24.6	22.9	25.3
8	*Tillandsia stricta*	16.6	26.9	37.4	26.3	33.0	26.2	23.3	35.1	35.5	41.2	42.4	31.8	43.5	37.5	28.8	49.3	31.8	50.4	42.2	67.3	39.4	73.6	38.9	75.7
9	*Tradescantia spathacea* 'Sitara'	23.5	24.8	25.5	24.8	21.9	19.2	21.3	23.9	22.7	33.1	27.2	27.6	27.0	32.2	33.5	34.1	40.2	29.3	32.6	29.5	19.6	21.5	11.4	24.5
CD (0.05)	*Species*	82.21		121.52		2.45**		56.35		144.36		117.50		178.76		77.64		80.09		64.97		145.28		56.58	
	Systems	NS		57.28		NS**		NS		NS		55.39		NS		NS		NS		NS		NS		26.67	
	Species x Systems	NS		NS		NS**		79.69		NS		NS		NS		109.81		113.26		NS		NS		80.01	
	Tree like																								
10	*Chrysalidocarpus lutescens*	304.1	287.2	386.0	298.3	568.8	310.5	324.8	457.3	302.4	410.7	659.9	440.0	608.3	516.9	749.1	493.3	602.2	365.2	848.4	779.3	820.5	769.2	615.3	939.2
11	*Codiaeum variegatum* 'Delaware'	62.2	31.0	95.6	43.5	80.7	72.9	69.4	136.1	63.0	105.8	102.6	87.4	46.3	203.6	161.9	154.7	100.1	171.3	86.5	182.5	97.8	112.7	91.6	98.9
12	*Codiaeum variegatum* 'Punctatum aureum'	10.7	9.9	10.4	7.1	8.7	12.6	11.2	17.1	12.2	22.6	14.5	15.8	12.4	10.1	16.0	15.7	15.1	16.7	16.8	19.7	10.2	19.9	17.4	19.0
13	*Ficus benjamina*	11.0	11.5	15.4	11.9	18.7	11.9	13.7	11.8	11.0	9.7	14.1	12.7	11.3	10.3	12.5	16.6	12.3	10.8	12.3	13.7	13.4	12.8	15.6	10.3
14	*Licuala grandis*	156.0	196.6	309.1	378.8	185.8	187.9	297.9	213.1	254.2	275.9	534.5	586.3	583.7	632.7	880.7	664.1	566.1	640.0	492.0	884.2	779.3	508.6	683.2	548.7
15	*Polyscias guilfoylei*	20.2	16.3	20.4	16.6	19.7	17.7	12.0	21.5	19.7	23.6	18.0	17.6	26.2	17.2	36.4	25.9	33.8	19.3	31.3	23.1	23.6	47.3	30.2	54.7
16	*Polyscias paniculata* 'Variegata'	41.3	32.5	40.2	42.8	63.3	48.8	43.3	36.5	67.5	43.3	56.1	51.0	79.1	43.1	35.2	75.8	66.5	55.2	96.2	35.3	28.3	55.6	48.5	53.2
17	*Rhapis excelsa*	93.8	168.8	97.7	230.5	56.5	133.9	77.4	141.8	49.1	255.2	65.5	242.1	56.5	306.6	59.6	346.4	74.7	324.5	121.4	266.9	127.2	273.8	80.4	306.5
18	*Schefflera arboricola*	140.2	109.9	88.0	86.1	100.3	90.8	77.6	114.3	120.7	96.3	91.5	79.3	114.9	123.0	93.9	124.0	122.6	127.2	145.2	147.7	144.0	96.7	190.9	107.3
CD (0.05)	*Species*	1.07**		1.81**		1.87**		34.30		2.02**		118.17		78.66**		64.16		79.69**		63.9**		45.45**		42.05**	
	Systems	NS**		NS**		NS**		16.17		0.95**		NS		NS**		NS		NS**		30.12**		NS**		19.82**	
	Species x Systems	1.51**		2.56**		2.65**		48.51		2.86**		NS		111.24**		90.74		112.7**		90.37**		64.27**		59.47**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	87.0	104.8	77.7	103.8	86.3	101.6	105.1	122.9	106.1	167.3	143.7	214.6	142.1	187.7	201.3	201.4	285.4	214.9	121.1	223.1	178.2	265.4	156.7	234.1
20	*Chrysothemis pulchella*	17.1	60.3	30.2	148.8	50.2	66.9	76.3	111.2	65.0	40.6	44.6	34.8	54.6	77.3	65.6	50.0	60.8	38.5	49.9	61.5	101.3	92.0	37.2	76.4
21	*Costus curvibracteatus*	38.5	67.4	98.4	68.3	100.8	66.5	105.7	78.1	51.3	67.0	69.5	71.7	63.2	42.1	64.9	85.7	68.2	66.0	58.2	57.7	59.4	92.4	72.5	85.7
22	*Iris innominata*	115.3	95.1	148.4	108.9	163.5	109.0	141.7	167.7	100.6	137.1	138.3	163.3	125.8	147.2	117.6	129.9	180.0	120.2	99.2	133.1	161.7	112.9	165.2	117.9
23	*Kalanchoe blossfeldiana*	16.7	33.5	16.0	35.9	17.1	39.4	39.9	55.0	51.0	50.5	64.1	80.2	27.5	46.7	72.7	83.4	27.2	40.8	66.5	54.6	58.3	38.7	37.6	35.6
24	*Spathiphyllum wallisii*	132.9	93.4	155.7	86.2	151.9	79.2	116.7	128.2	111.8	125.7	121.8	135.9	135.6	128.4	203.3	169.0	126.2	107.2	135.3	146.0	154.1	164.9	145.9	148.5
25	*Tacca chantrieri*	144.2	173.0	274.6	148.2	313.2	125.1	224.7	216.9	212.3	284.7	413.5	195.8	379.6	253.3	364.8	297.7	377.2	270.0	309.7	231.7	316.4	132.1	191.8	127.3
CD (0.05)	*Species*	32.70		30.74		20.14		41.99		37.28		27.79		56.98		59.59		36.12		43.54		30.94		21.82	
	Systems	NS		NS		10.76		NS		19.92		NS		NS		NS		19.21		23.27		NS		NS	
	Species x Systems	NS		43.48		28.48		NS		NS		39.31		NS		NS		NS		61.57		43.76		30.86	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

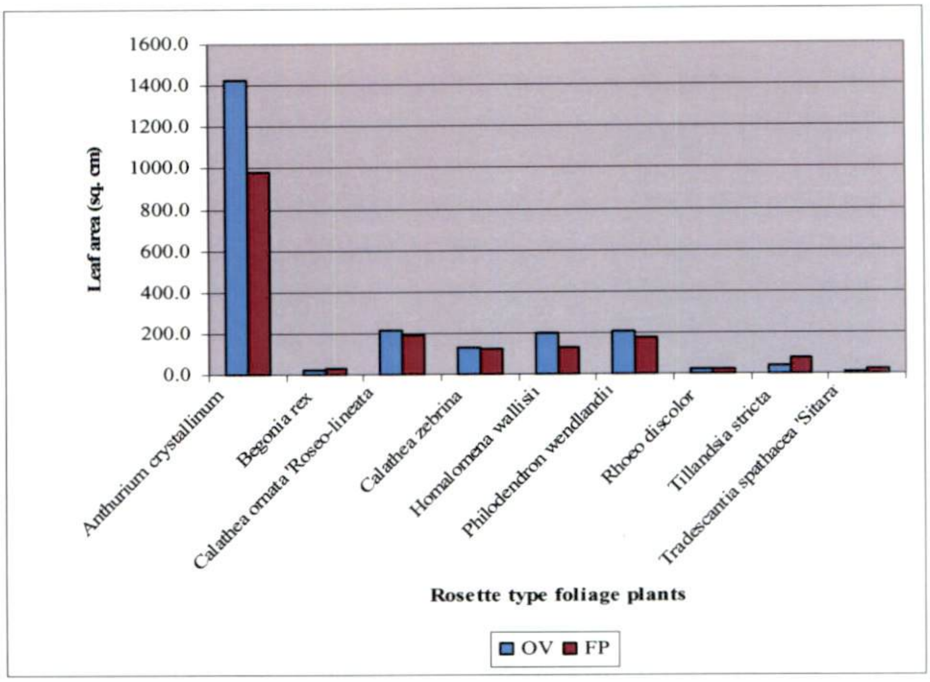
Table 6: Leaf area of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Leaf area (sq. cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	140.4	158.9	132.9	237.7	162.9	216.1	191.4	284.6	241.9	245.0	226.0	197.2	191.8	131.3	148.0	284.5	167.8	177.5	139.1	214.3	188.8	223.2	227.5	233.4
27	*Aglaonema pseudobracteatum*	110.3	162.8	126.9	172.6	133.4	125.3	135.6	159.4	121.6	149.0	147.7	121.5	84.2	124.2	109.9	173.5	94.6	155.6	108.7	129.8	138.3	145.7	133.9	137.8
28	*Alpinia zerumbet* 'Variegata'	130.2	121.0	135.2	125.1	145.0	88.4	157.7	86.9	121.4	83.7	116.8	123.5	117.7	124.8	111.3	185.2	124.7	229.1	178.2	175.1	218.7	143.0	166.1	152.6
29	*Dieffenbachia amoena*	371.8	269.8	346.5	313.8	488.1	336.3	261.2	354.3	323.6	299.6	430.2	376.7	389.8	374.0	405.2	341.8	491.8	343.2	346.1	421.0	323.9	532.7	349.0	565.3
30	*Dracaena* 'Purple Compacta'	26.9	40.8	32.7	44.7	25.9	41.7	31.8	48.1	36.1	49.6	41.5	17.9	29.2	46.1	46.9	46.1	40.4	38.1	31.4	40.4	27.2	34.6	23.8	37.2
31	*Dracaena marginata*	61.1	54.1	56.8	53.3	72.6	31.6	57.6	51.5	71.5	31.5	60.1	52.9	69.3	53.1	73.4	96.0	115.8	61.0	103.6	80.0	70.8	67.4	79.8	69.1
32	*Dracaena sanderiana*	17.0	14.4	21.5	31.1	35.8	27.1	21.7	24.5	24.2	42.1	57.5	50.6	31.2	37.2	45.5	49.2	46.6	45.3	45.5	50.2	51.5	47.2	56.9	49.0
33	*Nephrolepis exaltata*	192.0	115.2	192.8	130.7	213.7	219.5	219.3	197.7	214.0	303.2	238.4	237.3	197.5	282.1	290.5	280.9	264.9	433.2	298.3	199.7	232.9	257.6	234.7	228.8
34	*Peperomia clusiifolia*	14.8	20.6	26.9	12.7	14.2	13.9	17.5	11.4	21.7	9.8	29.1	22.1	15.5	17.4	34.5	24.4	33.3	28.0	23.7	20.9	33.0	16.7	35.7	16.9
35	*Peperomia obtusifolia* 'Sensation'	25.8	23.6	23.9	14.1	21.4	28.4	17.8	29.4	20.3	30.4	24.6	34.2	21.5	29.6	26.4	25.2	25.0	36.2	34.9	33.2	38.9	36.2	26.4	30.0
36	*Pleomele reflexa*	23.0	21.0	31.4	23.7	24.1	25.7	17.2	26.7	28.8	22.8	30.8	26.0	29.6	34.8	21.5	31.0	26.3	30.8	24.4	26.9	19.8	24.9	24.7	25.7
37	*Sansevieria trifasciata* 'Hahnii'	63.0	44.1	58.4	47.1	56.6	46.7	36.4	44.4	62.2	67.4	45.4	53.1	52.9	80.3	47.0	67.0	87.4	83.6	71.1	91.6	107.7	76.5	70.1	71.8
38	*Sansevieria trifasciata* 'Laurentii'	152.8	298.2	238.1	261.8	160.2	337.7	205.4	251.6	242.7	345.9	214.7	366.6	236.0	403.9	237.2	193.7	297.8	321.6	193.9	203.3	264.6	402.3	260.9	425.6
39	*Zamioculcas zamiifolia*	9.2	11.9	9.6	9.7	10.6	14.4	6.9	12.0	10.0	15.7	12.6	16.9	11.4	11.1	14.8	18.6	11.4	13.1	28.2	18.1	25.8	20.2	29.5	18.8
CD (0.05)	*Species*	1.13**		1.18**		1.3**		1.24**		1.26**		32.99		1.58**		0.96**		1.32**		32.31		22.34		22.28	
	Systems	NS**		NS**		NS**		0.46**		NS**		NS		0.59**		0.36**		NS**		NS		8.44		8.42	
	Species x Systems	1.61**		0.67**		1.85**		1.75**		1.78**		46.65		NS**		1.36**		1.87**		45.70		31.60		31.50	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	26.6	36.1	33.2	41.1	42.9	37.9	32.6	39.1	33.0	42.4	33.9	36.8	30.6	29.1	40.5	40.5	39.3	34.0	39.3	27.7	23.1	31.7	28.4	34.9
41	*Cyperus alternifolius*	379.8	309.9	317.4	287.9	294.8	222.1	258.8	412.3	249.8	296.1	539.0	378.7	531.9	512.3	467.5	397.8	486.3	243.1	575.7	404.2	397.9	367.2	512.2	376.2
42	*Ophiopogon jaburan*	23.0	33.0	39.8	29.2	35.8	24.6	35.5	31.1	26.1	29.4	33.9	28.7	38.5	41.2	42.3	52.8	36.9	32.0	32.7	61.4	25.0	42.6	40.9	40.1
43	*Ophiopogon jaburan* 'Variegata'	22.2	29.0	34.2	33.8	32.5	32.8	23.8	30.3	17.2	212.8	28.2	32.2	27.2	39.4	24.4	31.2	43.8	28.6	31.6	52.0	27.9	25.8	29.7	28.8
44	*Scirpus cernuus*	6.7	13.1	6.5	6.4	4.0	6.1	5.0	6.4	6.1	9.0	3.9	6.4	6.6	6.3	4.3	21.3	6.1	4.9	6.2	6.5	4.9	6.5	14.2	6.7
CD (0.05)	*Species*	0.71**		0.68**		0.93**		1.02**		3.64**		0.92**		0.9**		0.71**		0.89**		0.71**		0.81**		0.64**	
	Systems	NS**		NS**		NS**		0.65**		NS**		NS**		NS**		NS**		0.56**		NS**		NS**		0.4**	
	Species x Systems	1.01**		NS**		NS**		1.45**		NS**		1.3**		NS**		1**		1.26**		1.01**		NS**		0.91**	
	Climbing & Trailing																								
45	*Asparagus setaceus*	46.9	84.5	46.9	7.3	179.8	49.5	34.1	46.2	53.6	40.6	22.6	51.0	50.3	52.4	98.6	45.8	97.6	36.7	84.5	101.0	60.7	29.8	70.0	24.4
46	*Philodendron* 'Ceylon Gold'	103.3	142.9	80.1	146.1	117.3	121.8	112.0	197.0	155.4	101.7	209.9	145.7	217.1	144.0	257.9	221.3	174.9	246.4	267.5	184.8	298.7	154.6	237.7	130.1
47	*Philodendron elegans*	155.5	219.9	420.2	280.9	241.1	203.9	224.2	410.6	238.2	293.0	546.4	182.8	320.0	352.1	210.3	157.3	278.3	208.8	462.0	251.0	237.7	142.9	447.2	198.4
48	*Scindapsus aureus*	42.3	30.7	44.2	31.2	59.9	57.7	54.2	37.3	123.6	48.3	90.4	61.5	78.5	63.2	83.5	59.6	59.7	47.7	48.1	20.8	45.4	114.5	49.6	59.2
49	*Syngonium podophyllum*	21.8	67.4	41.0	67.1	55.4	80.3	36.6	73.8	55.4	89.1	104.3	77.5	24.4	73.2	42.5	110.5	95.6	98.5	93.3	115.0	131.5	94.7	116.6	96.4
50	*Syngonium wendlandii*	48.0	45.7	43.4	49.6	42.8	45.0	26.5	29.7	37.6	44.3	59.3	41.6	57.5	41.6	71.6	87.0	43.5	43.7	64.5	39.5	63.8	42.8	37.2	45.9
CD (0.05)	*Species*	27.67		1.66**		23.20		26.87		46.83		33.79		82.37		44.22		39.50		41.65		23.74		28.82	
	Systems	15.97		NS**		13.39		15.51		NS		19.51		NS		NS		NS		24.05		13.70		16.64	
	Species x Systems	NS		2.35**		32.82		38.00		NS		47.79		NS		NS		NS		58.91		33.57		40.76	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

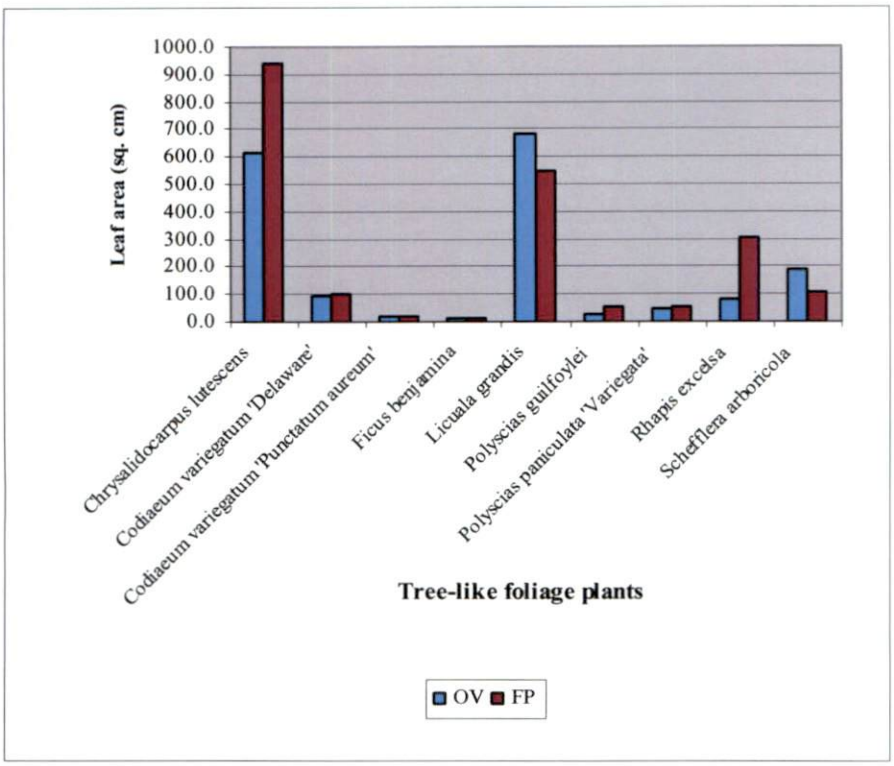
**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level



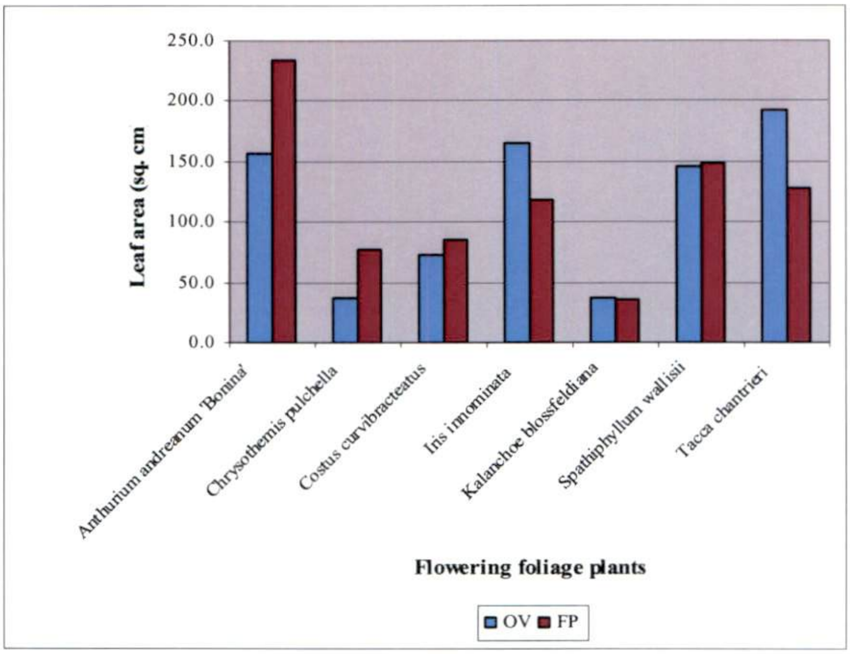
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 6. Leaf area of rosette type foliage plants in open ventilated and fan and pad greenhouses



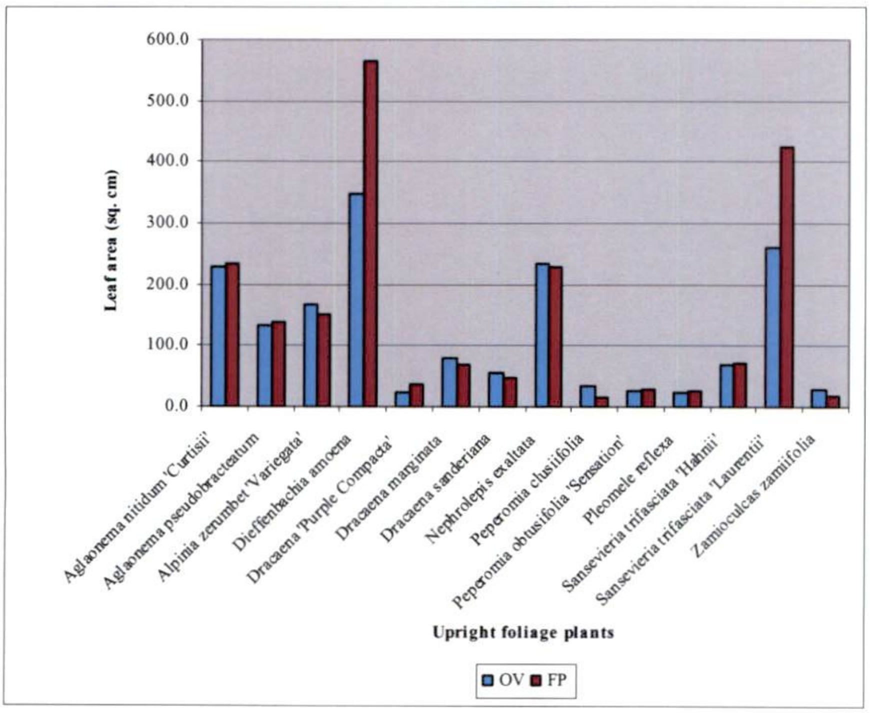
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 7. Leaf area of tree-like foliage plants in open ventilated and fan and pad greenhouses



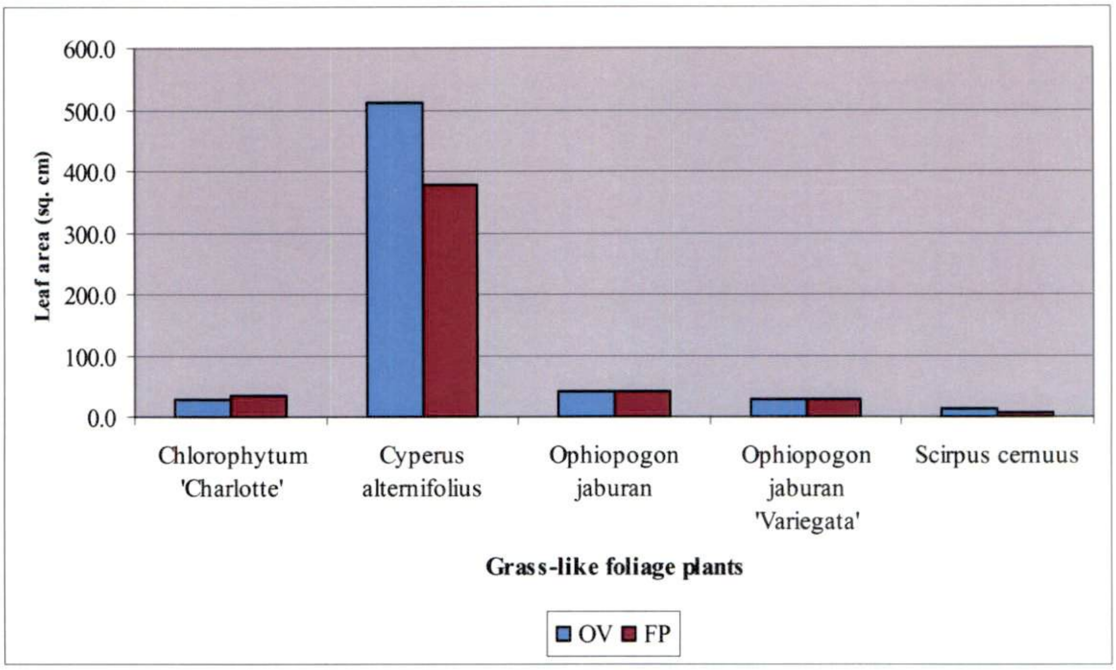
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 8. Leaf area of flowering foliage plants in open ventilated and fan and pad greenhouses



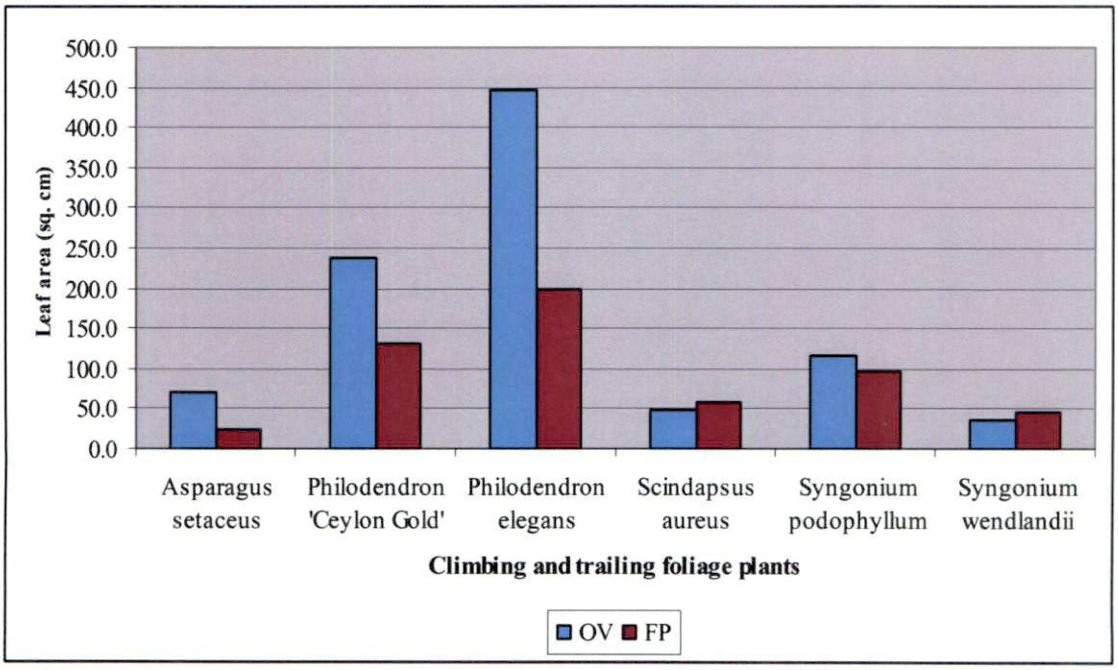
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 9. Leaf area of upright foliage plants in open ventilated and fan and pad greenhouses



OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 10. Leaf area of grass-like foliage plants in open ventilated and fan and pad greenhouses



OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 11. Leaf area of climbing and trailing foliage plants in open ventilated and fan and pad greenhouses

different result throughout the year except in 6th month, where no steady combinations had produced large area. However, during the last month, *Chrysalidocarpus lutescens* in FP (939.2 cm^2) was having the largest leaf area and the smallest leaf area was obtained from the following combinations and they were on par with other: *Codiaeum variegatum* 'Punctatum aureum' (17.4 & 19 cm^2), *Ficus benjamina* (15.6 & 10.3 cm^2), *Polyscias guilfoylei* (30.2 & 54.7 cm^2) and *Polyscias paniculata* 'Variegata' (48.5 & 53.2 cm^2) in both OV and FP respectively.

Among flowering plants, *Tacca chantrieri* had the maximum leaf area during the first nine months and 11th month, but during the last month, *Anthurium andreanum* 'Bonina' had the maximum leaf area. The minimum leaf area was recorded in *Kalanchoe blossfeldiana* during most of the months. Among the growing systems, the plants in OV was found to have the broadest leaves than FP during 3rd, 9th and 10th months and during 5th month it was just the opposite. Among the combinations, *Tacca chantrieri* in OV had the broadest leaves during most of the months, but during the last month, it was *Anthurium andreanum* 'Bonina' in FP (234.1 cm^2). *Chrysothemis pulchella* in OV (37.2 cm^2) and *Kalanchoe blossfeldiana* in OV (37.6 cm^2) and FP (35.6 cm^2) were having the smallest leaves.

The broadest and the narrowest leaves among upright plants were recorded in *Dieffenbachia amoena* and *Zamioculcas zamiifolia* throughout the year. During the last month, in FP, plants had more leaf area than in OV and during 4th, 7th and 8th months also the same kind of significant difference was observed. During the end of the year, *Dieffenbachia amoena* in FP (565.3 cm^2) had the maximum leaf area and *Dracaena* 'Purple Compacta', *Peperomia clusiifolia*, *Peperomia obtusifolia* 'Sensation', *Pleomele reflexa* and *Zamioculcas zamiifolia* in both systems had the minimum leaf area.

Among the grass-like plants, *Cyperus alternifolius* and *Scirpus cernuus* were the species that had the broadest and the narrowest leaves. The significant difference among the growing systems were not steady, however during the year end, in OV, plants had the larger leaf area than FP. During the year end, *Cyperus alternifolius* in OV (512.2 cm^2) and *Scirpus cernuus* in FP (6.7 cm^2) had the broadest and narrowest leaf area.

In climbing & trailing plants, *Philodendron elegans* recorded the largest leaf area throughout the year except in 11th month when it was *Philodendron* 'Ceylon Gold'. *Syngonium wendlandii*, the least throughout the year was on par with all the remaining other species in one or the other months. The significant difference among the growing systems was not constant, but during the year end, in OV, plants possessed more leaf area than the other. As for the interaction effect, *Philodendron elegans* in OV and *Asparagus setaceus* in FP were found to have the maximum and the minimum leaf area during most of the months.

4.1.1.1.5. Number of leaves

The number of leaves is an important parameter to be considered because it denotes the health status of a plant. The various physiological functions like photosynthesis, transpiration and the capability to tolerate air pollution etc. depend on the number of leaves of plant. The number of leaves per plant was observed monthly and presented in the Table 7.

Among rosette type, *Tradescantia spathacea* 'Sitara' and *Tillandsia stricta* were the species which had maximum leaves throughout the year except during the third month and last month respectively. Those species were on par with *Begonia rex* throughout the year except in the first month; and *Rhoeo discolor* during 1^{st}, 3^{rd} and 6^{th} to 12^{th} months. The lowest number of leaves was observed in *Anthurium crystallinum* and it was on par with *Calathea ornata* 'Roseo-lineata' throughout the year except last month and *Calathea zebrina* between 2^{nd} and 8^{th} months. Between the growing systems, plants in FP exceeded the number of leaves of plants in OV during the first three months, after which there was no significant difference. Interaction between species and systems had given significant result only during first month, when *Begonia rex* (54.3), *Tillandsia stricta* (47.3) and *Tradescantia spathacea* 'Sitara' (55) in FP had maximum number of leaves and *Anthurium crystallinum* (3.7 and 3.3), *Calathea ornata* 'Roseo-lineata' (5.0 and 2.7) in OV and FP, and *Calathea zebrina* (6.3) in FP had the least number of leaves.

Codiaeum variegatum 'Punctatum aureum' was the species that had the maximum number of leaves throughout the year among tree-like foliage plants and it was on par with *Ficus benjamina* during the first and third months. *Chrysalidocarpus lutescens*, *Licuala grandis* and *Rhapis excelsa* were the species that had the minimum number of leaves throughout the year and they were on par with each other. FP facilitated the plants to have more number of leaves than OV. *Codiaeum variegatum* 'Punctatum aureum' in FP was the best combination that had the highest number of leaves, which recorded 280.3 leaves on last month of observation and *Ficus benjamina* in OV was on par with the best value during the second month with 166.3 number of leaves. The combinations which had the lowest number of leaves were *Chrysalidocarpus lutescens*, *Licuala grandis* and *Rhapis excelsa* in both OV and FP throughout the year except during 8th and 9th months where significant results were not obtained.

When the flowering type foliages were concerned, the maximum number of leaves was observed in *Kalanchoe blossfeldiana* throughout the year and it was at par with *Chrysothemis pulchella* between 4th and 8th months. Among the growing systems, significant result was obtained only during first three months, when FP excelled OV. The interaction also produced significant variations only during 3rd, 9th and 10th months, where *Kalanchoe blossfeldiana* in FP (90.3 leaves on 10th month) had the maximum number of leaves and *Anthurium andreanum* "Bonina' and *Tacca chantrieri* in both OV and FP, *Iris innominata* and *Spathiphyllum wallisii* in OV had the lowest number of leaves.

Among the upright plants, maximum number of leaves was recorded in *Draceana* 'Purple Compacta' from 1st to 9th month and in *Pleomele reflexa* from 4th to last month. The lowest number of leaves was recorded in *Alpinia zerumbet* 'Variegata', *Dieffenbachia amoena* and *Sansevieria trifasciata* 'Laurentii' throughout the year and they were on par with each other. Significant variations among the growing systems were observed only during the last six months when OV performed better than FP. The combinations produced significant variation during 3rd, 5th, 6th and 9th months where a steady effect was produced during those period in *Dracaena* 'Purple Compacta' in OV which had 78 leaves during 9th month. The combinations which had the lowest number of leaves were *Sansevieria trifasciata* 'Laurentii' in both systems; *Alpinia zeumbet* 'Variegata', *Dieffenbachia amoena* and *Peperomia clusiifolia* in FP.

Scirpus cernuus is the only species among grass-like plants which had the maximum number of leaves throughout the year and *Cyperus alternifolius*, the minimum. *Chlorophytum* 'Charlotte' was on par with the lowest value during the last eight months. The growing systems had significant variations only during the first three months, when FP excelled OV. The interaction effect produced significant results only during first two and fifth months, when *Scirpus cernuus* (145.7 leaves during 5th month) in FP and *Cyperus alternifolius* in both systems had the highest and the lowest number of leaves respectively.

Among climbing and trailing plants, *Scindapsus aureus* and *Syngonium podophyllum* had maximum number of leaves throughout the year and they were on par with each other. During the last seven months, *Asparagus setaceus* was also at par with the highest value. The plants kept in OV had more number of leaves than plants in FP between third and eleventh

Table 7: Number of leaves of foliage plants in two growing systems in different months

S. No.	Plant species	Number of leaves																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	3.7	3.3	3.7	3.7	4.3	4.7	4.7	4.3	5.3	4.7	4.3	4.3	4.0	3.3	4.7	2.7	4.3	3.0	4.0	3.0	4.0	3.0	3.7	3.0
2	*Begonia rex*	9.0	54.3	27.7	55.0	44.3	50.0	66.7	49.0	71.3	53.7	74.3	63.3	78.0	65.3	85.7	71.3	88.3	79.7	95.0	86.3	99.7	91.7	109.7	102.3
3	*Calathea ornata* 'Roseo-lineata'	5.0	2.7	3.7	2.7	4.3	5.0	5.0	6.3	5.0	6.0	4.7	6.7	4.7	6.3	4.7	8.0	4.7	10.3	4.7	12.7	4.7	13.7	6.0	13.7
4	*Calathea zebrina*	8.7	6.3	8.0	6.3	7.3	6.7	8.3	7.3	7.0	9.0	6.7	8.7	8.0	9.3	8.7	10.3	9.0	12.7	9.0	14.7	7.7	16.0	10.0	16.0
5	*Homalomena wallisii*	7.7	13.0	10.3	13.0	13.7	16.0	17.3	16.3	20.0	18.0	23.0	19.3	24.0	21.7	21.7	25.0	22.7	27.7	25.0	29.7	26.7	31.3	28.7	32.7
6	*Philodendron wendlandii*	8.0	27.3	8.7	27.3	9.0	28.3	8.3	27.7	8.7	29.0	12.3	30.7	13.3	32.3	14.7	34.3	15.7	37.0	17.0	39.0	17.3	41.0	18.0	43.0
7	*Rhoeo discolor*	23.7	32.0	20.7	33.0	31.3	40.0	39.3	33.7	42.0	47.3	53.0	51.0	67.3	56.0	77.3	70.7	82.7	80.7	96.3	87.3	105.0	101.0	119.3	113.7
8	*Tillandsia stricta*	22.0	47.3	34.3	48.3	48.7	42.7	57.0	45.3	61.7	50.3	65.7	55.3	70.3	58.3	76.7	64.3	81.0	68.7	85.7	74.3	91.7	78.0	97.0	81.7
9	*Tradescantia spathacea* 'Sitara'	15.3	55.0	48.0	41.7	22.7	38.3	78.3	46.3	80.7	52.7	85.7	57.7	87.0	63.3	89.3	72.0	93.0	78.0	100.0	85.0	103.0	92.3	119.7	97.3
CD (0.05)	*Species*	0.6**		0.91**		0.89**		1.05**		1.19**		1.37**		1.39**		1.35**		1.32**		1.28**		1.29**		1.26**	
	Systems	0.28**		0.43**		0.42**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	0.85**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Tree like																								
10	*Chrysalidocarpus lutescens*	4.3	5.3	4.7	5.3	5.3	5.3	5.7	5.7	5.3	5.3	6.0	6.0	5.7	6.0	5.7	6.3	5.3	6.7	5.7	6.7	6.3	6.7	6.3	6.7
11	*Codiaeum variegatum* 'Delaware'	22.3	25.7	37.0	26.3	29.0	28.3	36.7	28.7	39.0	29.7	38.3	30.0	34.7	29.3	36.3	30.0	36.0	29.3	39.3	25.0	40.0	25.3	42.0	27.7
12	*Codiaeum variegatum* 'Punctatum aureum'	74.3	190.0	120.3	194.3	88.0	199.0	85.0	205.0	95.3	213.0	102.3	221.7	111.3	228.0	121.0	248.0	128.0	254.7	133.0	264.0	143.0	266.7	154.3	280.3
13	*Ficus benjamina*	134.7	82.0	166.3	82.7	161.7	84.7	77.7	80.3	64.7	83.7	58.7	74.3	50.7	69.3	42.7	73.3	43.0	59.3	39.0	62.0	29.3	67.7	22.7	78.0
14	*Licuala grandis*	7.7	9.7	8.0	9.7	10.0	10.3	8.0	10.7	9.0	11.3	8.7	11.3	10.0	11.3	10.3	12.0	11.0	11.3	11.7	11.7	12.3	10.3	11.7	11.3
15	*Polyscias guilfoylei*	35.3	59.7	69.3	60.7	39.3	63.0	47.0	65.0	51.3	68.0	52.7	71.3	55.0	71.7	56.7	73.7	58.3	77.3	60.7	79.7	64.3	82.0	69.7	85.7
16	*Polyscias paniculata* 'Variegata'	14.7	51.3	21.3	51.7	31.0	53.7	35.0	52.3	35.0	53.7	36.0	49.0	36.7	49.3	29.7	51.3	30.3	53.3	23.3	54.0	28.0	55.0	27.7	57.3
17	*Rhapis excelsa*	6.7	11.0	7.0	11.0	6.0	11.3	6.0	12.0	6.3	12.0	6.7	13.3	8.0	13.3	8.3	13.3	8.3	14.3	9.7	14.7	10.7	15.0	11.3	15.0
18	*Schefflera arboricola*	24.0	32.7	22.7	33.0	32.7	36.7	35.7	38.0	40.7	40.0	42.0	42.3	43.0	43.3	45.0	44.3	44.3	48.0	46.0	50.0	49.7	50.3	50.0	52.7
CD (0.05)	*Species*	0.98**		1.08**		0.96**		0.96**		0.98**		0.96**		1.1**		1.25**		1.23**		1.2**		1.11**		1.06**	
	Systems	0.46**		NS**		0.45**		0.45**		0.46**		0.45**		0.51**		0.58**		0.58**		0.56**		0.52**		0.5**	
	Species x Systems	1.39**		1.53**		1.36**		1.36**		1.39**		1.36**		1.55**		NS**		NS**		1.7**		1.57**		1.51**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	6.7	6.7	7.3	6.7	7.7	7.7	9.0	8.0	10.0	8.3	11.3	8.3	12.3	6.0	12.3	6.3	8.3	6.0	9.7	5.7	9.7	5.7	10.3	5.7
20	*Chrysothemis pulchella*	10.7	16.0	5.0	18.0	12.0	20.7	36.0	25.3	56.3	35.7	65.0	43.7	73.7	47.0	69.7	50.3	71.0	18.0	73.3	17.3	25.3	20.0	31.0	24.7
21	*Costus curvibracteatus*	5.7	8.7	7.0	8.7	7.7	8.7	10.3	8.7	9.0	8.7	9.0	8.7	9.0	8.7	9.0	24.0	9.0	24.0	31.7	24.0	31.7	26.3	31.7	27.3
22	*Iris innominata*	8.0	7.3	8.0	7.7	8.0	8.0	8.3	8.7	10.0	9.3	10.0	10.0	10.7	10.0	10.7	10.7	10.7	11.0	11.3	12.0	11.0	12.3	11.3	12.3
23	*Kalanchoe blossfeldiana*	9.7	32.3	15.0	33.7	13.0	39.7	18.0	44.3	25.0	55.0	31.7	65.7	41.7	70.3	52.3	76.3	58.3	85.0	76.3	90.3	88.3	96.7	96.3	103.3
24	*Spathiphyllum wallisii*	5.7	7.7	6.3	8.0	5.7	7.7	7.3	14.0	10.3	15.3	10.7	17.0	11.3	18.0	12.3	20.3	12.7	20.0	13.3	21.3	14.3	22.3	16.0	23.3
25	*Tacca chantrieri*	4.0	7.0	6.0	7.7	8.3	8.0	9.3	3.3	8.7	5.3	5.0	6.7	7.3	7.0	9.3	9.0	11.0	10.3	13.0	11.7	14.0	3.7	14.3	5.0
CD (0.05)	*Species*	0.69**		0.69**		0.68**		0.97**		1.13**		1.17**		1.2**		1.19**		1.1**		1.06**		0.85**		0.81**	
	Systems	0.37**		0.37**		0.36**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		NS**		0.96**		NS**		NS**		NS**		NS**		NS**		1.56**		1.51**		NS**		NS**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 7: Number of leaves of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Number of leaves																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	6.7	9.7	8.0	10.0	9.3	12.3	12.0	14.0	14.7	15.7	14.7	13.7	13.0	13.0	11.3	12.7	11.0	11.0	10.3	10.0	9.3	11.0	8.7	12.3
27	*Aglaonema pseudobracteatum*	12.0	14.0	14.7	12.0	16.3	14.0	21.0	14.7	21.3	16.0	21.7	17.0	21.3	17.3	22.0	17.7	23.0	19.3	24.3	20.7	26.3	21.7	28.0	23.7
28	*Alpinia zerumbet* 'Variegata'	8.3	9.3	8.0	9.0	8.0	8.7	10.0	7.3	10.3	7.0	11.7	8.0	9.3	8.3	10.0	7.7	10.0	6.7	9.0	7.0	9.3	7.0	8.7	7.0
29	*Dieffenbachia amoena*	6.0	9.3	7.0	9.3	8.0	10.3	9.3	9.7	9.7	8.0	9.0	9.0	9.3	9.0	8.7	9.0	10.0	9.3	9.0	7.7	10.0	7.3	10.7	7.7
30	*Dracaena* 'Purple Compacta'	56.0	47.7	68.3	48.0	94.7	51.7	61.0	54.3	66.0	56.3	71.0	57.7	74.7	57.7	76.3	60.0	78.0	50.0	80.3	43.3	70.0	45.0	64.7	47.7
31	*Dracaena marginata*	19.3	33.0	20.0	34.3	24.7	38.3	30.3	39.7	33.0	41.0	32.7	42.3	36.0	43.3	38.3	44.7	39.3	46.3	41.0	30.3	32.0	28.3	24.0	30.0
32	*Dracaena sanderiana*	17.3	24.0	21.7	24.0	21.7	25.7	26.0	27.0	30.3	30.0	34.3	31.0	37.3	32.3	39.3	34.0	40.3	36.0	40.7	38.0	42.7	40.0	43.3	42.0
33	*Nephrolepis exaltata*	27.7	22.3	22.7	23.0	20.3	27.3	26.7	31.7	30.7	35.3	33.3	38.3	37.7	39.7	43.3	40.7	45.0	44.7	48.0	47.0	50.7	48.7	53.0	51.3
34	*Peperomia clusiifolia*	9.3	17.0	13.7	17.7	15.3	14.7	17.7	14.7	21.7	4.0	21.7	4.0	23.7	4.7	23.3	5.3	23.3	5.3	24.3	6.3	25.3	6.3	28.3	7.3
35	*Peperomia obtusifolia* 'Sensation'	18.0	22.0	28.3	22.0	32.3	24.3	37.7	27.0	42.7	31.3	47.0	34.0	52.0	34.3	55.7	36.0	56.7	39.0	58.7	44.0	61.0	47.7	66.3	52.7
36	*Pleomele reflexa*	31.7	37.7	41.7	38.0	52.0	41.3	59.0	45.0	65.3	49.7	69.3	53.7	74.3	55.0	88.3	58.0	91.0	61.3	95.3	64.0	99.3	67.7	106.0	70.7
37	*Sansevieria trifasciata* 'Hahnii'	11.3	12.0	12.7	12.3	12.7	13.0	11.0	13.7	12.3	13.7	12.7	13.7	12.7	13.7	12.7	13.7	12.7	15.0	14.3	15.0	15.3	15.0	15.3	15.0
38	*Sansevieria trifasciata* 'Laurentii'	5.7	5.0	6.7	5.3	7.0	6.0	7.0	5.3	7.3	5.0	8.0	5.0	8.0	5.0	8.0	5.3	8.0	5.3	7.3	5.3	7.3	5.3	7.3	5.3
39	*Zamioculcas zamiifolia*	14.3	15.3	14.3	15.3	14.3	15.7	14.3	15.7	13.7	16.0	13.7	16.0	14.0	18.0	16.0	18.0	16.0	18.0	20.7	18.0	20.7	18.0	20.7	18.0
CD (0.05)	*Species*	0.75**		0.8**		0.76**		0.78		0.68**		0.7**		0.79**		0.79**		0.75**		0.89**		0.93**		0.93**	
	Systems	NS**		NS**		NS**		NS		0.26**		0.26**		0.3**		0.3**		0.28**		0.33**		0.35**		0.35**	
	Species x Systems	NS**		NS**		1.07**		NS**		0.97**		0.99**		NS**		NS**		1.06**		NS**		NS**		NS**	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	23.7	43.0	33.0	43.0	31.3	46.0	46.0	30.3	51.0	17.0	39.7	20.3	40.0	22.3	41.0	24.7	41.3	27.3	28.3	27.7	22.0	30.0	25.0	32.7
41	*Cyperus alternifolius*	10.3	22.0	13.3	22.3	8.0	20.0	11.7	22.3	13.0	25.0	15.3	28.0	17.7	30.7	19.0	24.7	20.3	26.3	16.3	28.0	18.3	27.7	22.7	30.7
42	*Ophiopogon jaburan*	51.3	62.7	39.3	63.0	61.3	67.0	68.0	70.0	72.7	72.7	75.3	75.3	79.0	76.3	81.7	79.0	84.0	82.0	87.0	87.3	89.7	89.3	93.3	93.0
43	*Ophiopogon jaburan* 'Variegata'	47.3	63.0	63.3	64.0	65.3	68.0	72.3	71.7	78.0	76.0	82.0	78.7	86.7	81.0	90.3	84.3	92.7	87.7	96.0	92.0	99.0	95.0	106.3	98.3
44	*Scirpus cernuus*	44.7	126.7	48.3	127.7	70.7	133.0	64.3	137.0	72.0	145.7	77.7	154.3	87.7	159.7	95.7	164.7	100.3	171.7	106.0	178.7	116.3	184.0	123.0	189.3
CD (0.05)	*Species*	12.58		13.37		1.19**		1.19**		1.3**		1.63**		1.58**		22.59		22.86		20.60		1.27**		21.74	
	Systems	7.96		8.45		0.75**		NS**		NS**		NS**		NS**		NS		NS		NS		NS**		NS	
	Species x Systems	17.80		18.91		NS**		NS**		1.84**		NS**		NS**		NS		NS		NS		NS**		NS	
	Climbing & Trailing																								
45	*Asparagus setaceus*	8.3	24.0	12.0	24.0	9.7	25.7	13.3	26.3	20.7	27.3	34.7	44.0	45.0	46.0	51.3	57.0	52.7	62.0	55.3	65.3	59.0	71.7	61.0	75.0
46	*Philodendron* 'Ceylon Gold'	15.0	16.7	15.3	16.7	17.0	17.0	21.0	17.3	18.0	18.3	17.7	19.0	19.3	18.7	19.3	16.3	19.7	15.0	22.0	16.7	23.7	18.7	25.7	23.3
47	*Philodendron elegans*	7.3	8.3	8.3	9.0	10.3	9.0	11.0	11.3	13.0	12.3	15.0	12.3	14.7	12.3	14.3	13.0	15.0	10.0	15.0	12.7	16.0	13.7	17.0	15.3
48	*Scindapsus aureus*	28.0	19.0	37.0	19.3	49.0	21.7	61.7	23.3	65.0	28.3	67.0	32.3	71.0	34.3	75.0	37.0	77.0	40.0	79.7	43.0	82.7	47.0	86.0	52.0
49	*Syngonium podophyllum*	23.0	16.0	36.7	16.7	48.7	19.3	61.0	21.0	64.3	20.7	68.0	23.0	72.0	23.7	76.0	26.0	74.0	29.3	78.0	32.3	82.3	34.7	85.7	37.7
50	*Syngonium wendlandii*	8.7	11.0	7.7	11.0	17.0	12.7	27.0	19.7	24.0	22.7	18.0	24.3	23.3	23.0	18.7	21.0	18.0	25.7	12.3	29.3	20.3	29.7	17.0	32.3
CD (0.05)	*Species*	0.8**		0.84**		0.74**		0.86**		0.81**		0.9**		0.86**		0.76**		0.68**		0.69**		0.79**		0.77**	
	Systems	NS**		NS**		0.43**		0.49**		0.46**		0.52**		0.49**		0.43**		0.39**		0.4**		0.45**		NS**	
	Species x Systems	NS**		1.19**		1.05**		1.21**		1.14**		1.28**		1.22**		1.07**		0.96**		0.98**		1.12**		1.09**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

months. The steady combinations which had produced maximum number of leaves (86 and 85.7 during the last month) were *Scindapsus aureus* and *Syngonium podophyllum* in OV. The minimum value recorded in combination effect throughout the year was *Philodendron elegans* in both the systems.

4.1.1.1.6. Internodal length (cm)

Internodal length is also an important character to be considered because it determines compactness and appearance of the plant. As far as foliage plants are concerned, the grass-like plants and some species like *Anthurium* and *Spathiphyllum wallisii* did not have measurable internodal length. However, the internodal length of remaining species were measured and found that they were significantly different with each other and the results were presented in the Table 8. So the comparison was made with the available species with internodes among different categories.

Among the rosette type plants, only four species had internodes. Among those, *Begonia rex* had the longest internodes and it was on par with *Tillandsia stricta* during 7th, 9th and 10th months. The shortest internodes were observed in *Tradescantia spathacea* 'Sitara' and it was on par with *Rhoeo discolor*. The significant difference between the growing systems was not so constant throughout the year. However, during the year end, plants in FP had more internodal length than OV. The combinations produced significant results only during 4th and 6th months when *Begonia rex* had 3.7 and 2.8 cm long internodes in OV and FP respectively. *Rhoeo discolor* and *Tradescantia spathacea* 'Sitara' in OV had the shortest internodes during 4th month and during 6th month in FP.

Ficus benjamina was the species among tree-like plants that had the longest internodes throughout the year and *Codiacum variegatum* 'Delaware' had the least except during 8th month. No growing system was steady to yield the dominant results over the other. However, during the year end, in FP, plants had more internodal length than in the other. During the year end, *Ficus benjamina* in OV (2 cm) and *Polyscias guilfoylei* in FP (2.5 cm) had the longest internodes; *Codiaeum variegatum* 'Delaware' (0.5 cm) and *Codiaeum variegatum* 'Punctatum aureum' (0.4 cm) in FP had the shortest.

Among the flowering plants, only three species had internodes and there was no significant difference between the species during the initial months. However, significance was observed during the year end at every level, when *Kalanchoe blossfeldiana* combined in

FP (5.4 cm) had the longest internodes and *Chrysothemis pulchella* in OV (1.2 cm) had the shortest.

Among upright plants, *Alpinia zerumbet* 'Variegata' had the highest internodal length throughout the year except during the 4th month when it was in *Dracaena sanderiana*. *Pleomele reflexa* had the shortest. As like other category of plants, here also there was unsteadiness in performance in the growing systems. However, at the end, OV produced internodes with more length than FP. From the interactions effect, it was observed that during the year end, *Alpinia zerumbet* 'Variegata' in both OV (4.0 cm) and FP (4.3 cm) had the longest internodes and *Dracaena marginata* in FP (0.5 cm) had the shortest.

In climbing and trailing type, throughout the experimental period, different species were observed to have the maximum and the minimum internodal length. However, during the end, *Philodendron elegans* had the longest internodes and *Syngonium podophyllum* was on par. The shortest was recorded in Philodendron 'Ceylon Gold' and it was on par with *Asparagus setaceus* and *Syngonium wendlandii*. During the same period, in OV, plants had the longest internodes than FP. *Philodendron elegans* (13.2 cm), *Scindapsus aureus* (11.2 cm) and *Syngonium podophyllum* (12.8 cm) in OV were the best combinations to have the longest internodes and; *Asparagus setaceus* (4.1 cm), *Philodendron* 'Ceylon Gold' (3.3 cm) in OV and *Syngonium wendlandii* in both OV (3.8 cm) and FP (3.9 cm), the shortest and they were at par.

4.1.1.1.7. Length and girth of petiole (cm)

As like any other characters, length and girth of petiole are also equally important as they support the leaves. The petiole length and girth were measured monthly and the results are presented in Tables 9 & 10. Some species did not have measurable length of petiole; however comparisons were made with the remaining species.

4.1.1.1.7.1. Petiole length (cm)

In rosette type plants, only six species possessed petiole and they were significantly different with each other with respect to petiole length. *Anthurium crystallinum* and *Begonia rex* had the lengthiest and the shortest petiole respectively. Among the growing systems, during the year end, OV exceeded FP and as for interaction effects, *Anthurium crystallinum* in OV (53.1 cm) and *Begonia rex* in both systems OV (2 cm) and FP (2.2 cm) were the best and the poorest combinations.

Table 8: Internodal length of foliage plants in two growing systems in different months

S. No.	Plant species	Internodal length (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*Begonia rex*	2.0	1.6	2.2	1.5	2.5	2.4	3.7	2.2	1.9	1.8	2.2	2.8	2.2	2.2	2.5	2.6	1.9	2.0	2.8	2.3	2.2	2.3	1.8	3.1
3	*Calathea ornata* 'Roseo-lineata'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	*Calathea zebrina**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	*Homalomena wallisii**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*Philodendron wendlandii**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	*Rhoeo discolor*	0.4	0.4	0.8	0.2	0.2	0.5	0.2	0.6	0.4	0.4	1.0	0.4	0.5	0.4	0.3	0.4	0.5	0.3	0.4	0.3	0.3	1.1	0.7	1.0
8	*Tillandsia stricta*	1.3	1.2	1.7	0.9	1.0	1.3	1.6	1.7	1.3	1.3	1.4	1.7	1.8	2.2	1.3	1.4	2.0	1.8	2.8	1.9	1.4	2.2	1.5	2.1
9	*Tradescantia spathacea* 'Sitara'	0.3	0.5	0.5	0.4	0.4	0.5	0.2	1.4	0.5	0.8	0.9	0.5	0.5	0.4	0.3	0.4	0.6	0.3	0.4	0.3	0.3	0.8	0.5	0.8
CD (0.05)	*Species*	0.08**		0.21**		0.08**		0.13**		0.09**		0.11**		0.16**		0.08**		0.12**		0.07**		0.06**		0.08**	
	Systems	NS**		0.14**		0.05**		0.09**		NS**		NS**		NS**		NS**		NS**		0.05**		0.04**		0.05**	
	Species x Systems	NS**		NS**		NS**		0.19**		NS**		0.16**		NS**		NS**		NS**		NS**		0.09**		0.11**	
	Tree like																								
10	*Chrysalidocarpus lutescens**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	*Codiaeum variegatum* 'Delaware'	0.6	0.6	0.6	0.4	0.9	0.6	0.5	0.8	0.4	0.9	0.8	2.2	0.8	0.8	2.1	0.7	1.5	0.9	0.3	2.0	0.4	0.8	0.5	0.8
12	*Codiaeum variegatum* 'Punctatum aureum'	0.8	1.0	0.8	0.5	0.8	0.4	1.4	0.6	0.6	0.6	1.2	1.4	0.5	0.6	1.0	0.8	0.7	1.0	1.6	0.5	0.8	0.8	0.4	0.8
13	*Ficus benjamina*	1.8	3.5	3.1	2.0	3.6	1.5	3.0	2.7	2.7	2.2	2.9	2.8	2.5	2.7	2.8	2.8	2.8	2.5	2.8	3.0	3.6	1.5	2.7	2.0
14	*Licuala grandis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*Polyscias guilfoylei*	1.3	2.5	1.5	2.2	2.8	2.1	2.0	2.8	1.5	2.2	2.2	2.8	2.0	2.9	1.8	2.8	1.8	2.6	1.9	2.6	2.0	3.0	2.0	2.5
16	*Polyscias paniculata* 'Variegata'	1.5	2.7	2.2	1.5	2.9	2.7	3.8	1.9	2.1	2.0	2.9	1.7	3.0	1.6	2.7	1.3	2.5	1.3	3.3	0.7	2.8	1.1	0.7	1.0
17	*Rhapis excelsa*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	*Schefflera arboricola*	2.0	2.6	2.8	1.0	1.8	1.6	2.3	2.3	1.6	2.6	1.7	2.7	2.7	2.9	2.3	2.5	2.1	1.9	2.0	2.0	1.0	1.5	1.7	2.0
CD (0.05)	*Species*	0.18**		0.25**		0.18**		0.12**		0.11**		0.17**		0.17**		0.1**		0.08**		0.06**		0.06**		0.09**	
	Systems	0.1**		0.14**		0.1**		0.07**		0.06**		NS**		NS**		0.06**		0.04**		0.03**		0.04**		0.05**	
	Species x Systems	NS**		NS**		NS**		0.17**		0.16**		0.25**		NS**		0.15**		0.11**		0.09**		0.09**		0.13**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	*Chrysothemis pulchella*	0.9	1.3	2.7	1.5	0.9	1.5	1.5	2.1	2.3	2.2	3.2	1.4	2.2	2.0	1.2	1.1	1.9	0.6	1.2	2.2	2.6	2.3	1.2	2.1
21	*Costus curvibracteatus*	1.6	2.2	1.7	1.7	2.5	2.9	2.9	1.9	2.0	2.6	2.2	2.8	1.9	1.9	2.4	4.0	2.7	2.8	3.0	2.4	3.1	2.8	2.6	2.5
22	*Iris innominata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*Kalanchoe blossfeldiana*	1.4	0.6	2.3	1.1	0.7	0.9	0.8	2.1	0.4	1.7	1.5	1.1	1.3	1.2	1.2	1.9	0.9	2.3	2.0	1.3	4.9	6.9	2.4	5.4
24	*Spathiphyllum wallisii**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	*Tacca chantrieri**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CD (0.05)	*Species*	NS**		NS**		0.2**		NS**		0.1**		0.13**		NS**		0.08**		0.1**		0.13**		0.21**		0.09**	
	Systems	NS**		NS**		NS**		NS**		0.08**		NS**		NS**		0.06**		NS**		NS**		NS**		0.08**	
	Species x Systems	NS**		NS**		NS**		NS**		0.15**		0.18**		NS**		0.11**		0.14**		0.19**		NS**		0.13**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants with no intrenodes

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 8: Internodal length of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Internodal length (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	2.0	1.8	1.9	1.9	1.5	1.8	1.9	2.1	2.1	1.6	2.3	1.9	1.9	1.9	1.6	1.6	1.7	1.0	2.7	1.2	2.2	1.3	2.4	1.3
27	*Aglaonema pseudobracteatum*	1.2	1.8	1.6	1.3	1.7	1.7	2.0	2.1	2.0	1.9	2.2	1.8	1.3	1.7	1.9	1.7	1.6	2.3	1.7	2.0	1.6	2.1	2.0	1.7
28	*Alpinia zerumbet* 'Variegata'	3.5	2.5	3.6	3.4	3.5	2.0	2.3	2.0	3.4	4.8	3.8	4.3	4.3	3.1	2.9	3.7	5.1	3.9	3.4	5.2	4.1	4.1	4.0	4.3
29	*Dieffenbachia amoena*	1.2	1.8	1.7	1.9	1.8	1.9	2.0	2.1	1.8	1.5	1.6	1.8	1.9	1.9	1.8	1.6	1.4	1.8	1.9	1.4	1.8	1.5	1.7	1.7
30	*Dracaena* 'Purple Compacta'	0.8	0.7	0.9	0.7	0.7	1.0	0.6	0.6	0.8	1.1	0.8	0.8	1.0	0.8	0.9	0.6	0.6	0.9	0.9	0.7	0.6	0.8	0.8	0.7
31	*Dracaena marginata*	0.9	2.5	1.4	1.3	1.5	1.3	1.4	1.8	1.0	0.8	1.6	1.5	1.1	0.8	0.9	1.3	1.5	1.8	0.8	0.6	1.5	0.6	0.8	0.5
32	*Dracaena sanderiana*	1.9	3.7	2.7	3.7	1.9	3.3	2.1	3.5	3.0	2.9	2.7	3.1	4.3	3.0	3.4	3.9	2.6	3.7	3.0	3.2	3.1	3.4	3.0	3.7
33	*Nephrolepis exaltata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	*Peperomia clusiifolia*	0.5	0.5	0.9	0.8	0.4	1.4	0.8	0.5	0.9	0.6	1.7	0.7	0.6	0.4	1.8	0.5	1.6	0.4	2.7	0.5	2.0	0.5	1.5	0.4
35	*Peperomia obtusifolia* 'Sensation'	1.6	1.6	1.2	1.8	1.5	2.3	1.4	2.3	1.0	3.0	1.6	3.7	2.1	3.8	1.9	3.9	1.9	5.8	2.5	2.7	3.0	3.0	1.7	2.7
36	*Pleomele reflexa*	0.8	0.7	0.7	0.5	0.7	0.5	0.5	0.9	0.5	0.8	0.6	1.8	1.0	0.6	0.9	0.5	0.6	0.5	0.5	0.5	1.1	0.4	0.5	0.5
37	*Sansevieria trifasciata* 'Hahnii'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	*Sansevieria trifasciata* 'Laurentii'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	*Zamioculcas zamiifolia*	1.6	2.3	1.7	2.0	1.8	1.9	1.2	1.4	2.0	2.0	2.9	2.4	2.9	2.0	3.1	1.3	2.9	2.7	3.3	1.3	4.0	1.2	2.8	1.3
CD (0.05)	*Species*	0.19**		0.2**		0.17**		0.15**		0.09**		0.13**		0.15**		0.11**		0.08**		0.07**		0.08**		0.07**	
	Systems	0.08**		NS**		0.07**		0.06**		0.04**		NS**		0.06**		0.04**		0.03**		0.03**		0.03**		0.03**	
	Species x Systems	0.27**		NS**		0.24**		0.21**		0.14**		0.18**		0.22**		0.16**		0.12**		0.1**		0.11**		0.11**	
	Grass like																								
40	*Chlorophytum* 'Charlotte'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	*Cyperus alternifolius**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	*Ophiopogon jaburan**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	*Ophiopogon jaburan* 'Variegata'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	*Scirpus cernuus**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Climbing & Trailing																								
45	*Asparagus setaceus*	3.1	4.3	3.1	3.0	2.9	3.6	2.2	2.3	2.3	1.9	4.2	2.4	4.4	1.9	3.7	2.8	4.2	5.5	2.9	4.8	5.0	5.0	4.1	5.3
46	*Philodendron* 'Ceylon Gold'	4.5	2.7	1.3	3.5	4.5	4.0	2.9	5.1	3.1	3.1	2.7	7.7	2.9	5.9	4.9	6.5	5.8	6.1	5.8	4.7	5.6	4.8	3.3	5.0
47	*Philodendron elegans*	2.0	5.1	4.8	3.5	7.7	6.5	7.2	17.8	10.1	21.0	5.9	9.7	9.6	9.8	4.7	12.7	4.1	5.8	15.5	9.7	4.8	6.3	13.2	7.1
48	*Scindapsus aureus*	9.6	4.7	9.0	4.9	13.6	7.2	9.3	8.0	11.9	10.1	16.1	6.9	11.7	6.8	7.0	8.6	7.0	9.1	6.6	12.5	5.5	7.0	11.2	5.5
49	*Syngonium podophyllum*	14.3	2.8	9.0	1.6	7.0	4.8	10.1	8.7	8.4	9.7	10.8	8.1	11.5	7.1	5.4	8.5	9.0	9.9	6.0	12.1	6.8	10.0	12.8	9.8
50	*Syngonium wendlandii*	1.4	1.0	5.7	1.0	3.8	1.7	6.5	5.2	8.8	5.4	5.3	7.5	3.0	6.8	3.8	4.0	6.1	4.2	3.1	5.4	4.3	3.6	3.8	3.9
CD (0.05)	*Species*	0.4**		0.45**		0.33**		0.42**		0.48**		0.41**		0.39**		0.26**		0.21**		0.25**		0.11**		0.21**	
	Systems	0.23**		0.26**		0.19**		NS**		NS**		NS**		NS**		0.15**		NS**		0.14**		0.06**		0.12**	
	Species x Systems	0.57**		0.64**		NS**		0.59**		0.69**		0.58**		0.55**		0.37**		NS**		0.35**		0.16**		0.31**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants with no intrenodes

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Among tree-like plants, the longest and the shortest petiole length were recorded in *Chrysalidocarpus lutescens* and *Ficus benjamina* respectively. In FP, plants had lengthier petiole than in OV. The best combination which produced the longest petiole was *Chrysalidocarpus lutescens* (78.6 cm) in FP. The combination which had the shortest petiole was *Ficus benjamina* in OV (1.3 cm) and FP (1 cm) and this was on par with *Codiaeum variegatum* 'Punctatum aureum' (1.3 cm) in OV.

Anthurium andreanum 'Bonina' had the longest petiole among the flowering plants throughout the year, whereas the shortest petiole was recorded in *Chrysothemis pulchella* which was on par with *Costus curvibracteatus*. Among the growing systems, plants in FP had more length of petiole. The interactions produced significantly different result only during 11th month when *Anthurium andreanum* 'Bonina' (31.3 cm) and *Spathiphyllum wallisii* (26.3 cm) in FP; *Chrysothemis pulchella* (0.5 & 0.7 cm) and *Costus curvibracteatus* (0.3 & 0.5 cm) in both systems had the longest and the shortest petioles respectively.

Among the upright species, *Nephrolepis exaltata* recorded the lengthiest petiole during the last nine months. *Peperomia clusiifolia* and *Zamioculcas zamiifolia* recorded the shortest petiole and they were on par with each other. The growing systems produced significantly different results only during 9th month where OV was the best. Among the combinations, during the year end, *Nephrolepis exaltata* in OV (41.9 cm) was the highest petiole length; *Peperomia clusiifolia* (0.7 & 0.4 cm), *Pleomele reflexa* (0.8 & 0.6 cm) and *Zamioculcas zamiifolia* (0.3 cm in both) had the least petiole length irrespective of systems.

In grass-like species only two had petiole, in that *Cyperus alternifolius* (91.4 cm, the highest) always had more petiole length than *Chlorophytum* 'Charlotte' (5.2 cm, the lowest). The growing systems and its interaction with species had no significance.

Among the climbing & trailing plants, *Philodendron elegans* and *Aspaagus setaceus* had the lengthiest and the shortest petioles. Among the growing systems, FP produced more petiole length than OV during all the significant months. From the interaction effects, *Philodendron elegans* in FP (26.2 cm) and *Aspaagus setaceus* in OV (2.0cm) had the highest and the lowest petiole length during the year end.

4.1.1.1.7.2. Petiole girth (cm)

The same kind of pattern as that of petiole length was observed in petiole girth also. In rosette plants, *Philodendron wendlandii* and *Begonia rex* had the maximum and the

Table 9: Petiole length of foliage plants in two growing systems in different months

S. No.	Plant species	Petiole length (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	37.4	37.0	30.8	38.4	25.9	30.2	26.3	37.0	23.1	37.4	32.5	33.8	31.1	41.1	31.2	25.9	24.9	43.4	34.0	29.8	46.5	28.8	53.1	37.3
2	*Begonia rex*	3.0	1.7	2.3	2.0	2.8	2.3	2.2	2.7	2.6	1.3	1.6	2.3	1.6	1.5	2.4	2.0	1.9	2.0	2.5	2.1	1.4	2.0	2.0	2.2
3	*Calathea ornata* 'Roseo-lineata'	23.1	12.0	16.1	16.2	16.9	15.4	24.3	20.1	19.9	22.4	30.0	20.6	19.0	31.7	40.2	31.8	33.8	28.0	31.2	37.1	35.8	43.8	34.7	38.4
4	*Calathea zebrina*	11.7	14.0	8.6	11.9	12.4	11.5	12.1	14.4	16.5	17.0	17.7	14.7	12.6	14.4	18.4	21.7	15.5	19.0	18.4	15.9	18.8	16.1	20.3	16.2
5	*Homalomena wallisii*	7.1	8.4	4.0	9.7	8.0	9.6	11.1	15.4	11.0	14.9	11.5	8.5	19.1	12.3	12.0	15.6	15.1	12.2	11.2	13.6	12.0	7.8	13.2	8.1
6	*Philodendron wendlandii*	10.8	10.0	13.5	12.1	10.8	12.4	11.0	16.4	16.1	11.5	8.9	12.0	12.1	16.1	21.2	15.2	12.9	19.0	16.7	21.8	23.7	16.2	23.7	15.2
7	*Rhoeo discolor**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	*Tillandsia stricta**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	*Tradescantia spathacea* 'Sitara'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CD (0.05)	*Species*	0.57**		0.55**		0.67**		0.59**		0.81**		0.6**		0.7**		0.48**		0.44**		0.4**		0.53**		0.22**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.25**		NS**		0.3**		0.13**	
	Species x Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.62**		NS**		NS**		0.32**	
	Tree like																								
10	*Chrysalidocarpus lutescens*	43.0	45.3	39.7	38.4	33.6	52.7	29.9	41.2	29.3	28.2	47.7	41.8	28.5	56.6	44.5	50.8	49.9	53.0	68.9	77.1	62.0	76.2	49.9	78.6
11	*Codiaeum variegatum* 'Delaware'	2.6	0.9	2.7	1.0	1.2	1.0	4.2	1.6	1.8	2.1	2.9	2.7	2.6	3.0	3.9	2.8	4.5	2.5	1.9	3.8	2.1	2.6	2.2	2.7
12	*Codiaeum variegatum* 'Punctatum aureum'	1.2	1.3	1.3	1.0	1.2	1.7	1.0	2.1	1.3	2.4	2.0	1.6	1.4	2.0	1.7	1.9	1.6	2.4	2.0	2.2	1.4	2.6	1.3	2.5
13	*Ficus benjamina*	0.8	0.8	0.9	1.3	1.0	1.0	0.8	1.1	1.1	0.8	1.1	1.0	0.9	0.9	0.7	1.4	1.1	1.0	0.9	1.0	1.2	1.0	1.3	1.0
14	*Licuala grandis*	36.7	37.4	26.1	34.8	36.1	34.6	29.6	29.1	41.1	26.9	27.6	42.7	30.6	25.7	27.0	28.5	22.3	24.2	23.4	29.1	19.5	27.5	28.4	25.8
15	*Polyscias guilfoylei*	12.9	6.4	9.6	9.6	8.1	10.4	10.5	6.5	9.6	10.1	10.0	9.6	9.8	10.5	10.0	11.1	9.8	11.1	9.9	10.3	10.2	10.5	10.4	10.7
16	*Polyscias paniculata* 'Variegata'	8.6	5.5	9.4	10.3	8.6	10.0	10.2	9.7	6.5	10.0	10.4	10.8	10.2	10.3	10.0	10.8	10.1	10.5	10.8	10.8	10.0	10.8	9.6	11.0
17	*Rhapis excelsa*	8.9	14.7	12.2	13.5	10.2	15.5	12.1	19.8	11.0	17.6	11.5	20.8	12.8	22.4	14.5	26.6	10.4	23.2	9.7	31.0	15.1	15.7	19.0	17.2
18	*Schefflera arboricola*	10.8	9.2	11.3	10.2	11.0	10.6	13.8	12.4	12.6	10.8	13.6	11.8	12.0	16.2	14.0	13.0	11.6	13.2	13.8	11.6	16.2	9.0	16.8	12.6
CD (0.05)	*Species*	0.45**		0.47**		0.47**		0.31**		0.58**		0.44**		0.42**		0.28**		0.31**		0.25**		0.2**		0.22**	
	Systems	NS**		NS**		0.22**		NS**		NS**		NS**		0.2**		0.13**		0.15**		0.12**		0.09**		0.1**	
	Species x Systems	NS**		NS**		NS**		0.45**		NS**		0.63**		0.6**		0.4**		0.45**		0.36**		0.29**		0.31**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	17.8	20.7	13.1	19.9	17.6	19.1	15.4	18.4	18.9	22.2	17.7	25.6	21.5	26.9	22.1	25.2	26.1	21.4	21.6	20.7	24.4	28.6	21.8	31.3
20	*Chrysothemis pulchella*	0.8	0.3	0.5	0.5	0.3	0.3	0.5	0.2	0.3	0.5	0.2	0.4	0.3	0.4	0.4	0.3	0.4	0.3	0.6	0.4	0.5	0.7	0.3	0.8
21	*Costus curvibracteatus*	0.2	0.3	0.4	0.4	0.4	0.2	0.4	0.3	0.3	0.6	0.3	0.3	0.4	0.3	0.5	0.5	0.6	0.4	0.3	0.5	0.5	0.4	0.6	0.4
22	*Iris innominata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*Kalanchoe blossfeldiana*	1.3	1.8	1.2	2.3	1.8	2.4	2.2	2.1	2.8	3.1	3.4	3.6	2.4	2.6	3.0	4.6	2.4	2.9	4.6	2.9	4.0	2.4	2.5	2.5
24	*Spathiphyllum wallisii*	17.9	14.8	14.8	13.8	12.6	14.5	10.6	16.6	15.3	17.5	19.7	18.3	21.1	13.6	18.5	19.2	18.4	18.5	19.1	21.0	16.7	26.5	18.0	26.3
25	*Tacca chantrieri*	10.9	11.2	13.1	11.4	15.8	13.5	14.3	18.2	13.9	19.1	22.3	21.5	18.9	19.2	20.9	21.4	21.0	18.9	21.8	20.2	17.0	16.3	18.6	21.4
CD (0.05)	*Species*	0.44**		0.27**		0.36**		0.34**		0.33**		0.39**		0.35**		0.33**		0.23**		0.28**		0.27**		0.22**	
	Systems	NS**		NS**		NS**		NS**		0.19**		NS**		NS**		NS**		NS**		NS**		NS**		0.12**	
	Species x Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.39**		0.31**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants with no petiole

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 9: Petiole length of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Petiole length (cm) – Months after planting: 1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	22.8	16.8	17.3	14.4	16.4	16.2	13.8	20.0	13.2	15.6	16.3	22.1	11.4	11.3	11.6	19.3	17.6	13.9	14.3	18.3	19.8	18.2	18.3	18.6
27	*Aglaonema pseudobracteatum*	15.1	15.6	14.7	16.4	13.8	12.8	12.4	17.5	15.5	15.5	14.8	18.4	14.5	18.6	9.8	18.3	12.3	11.4	15.0	18.2	13.0	16.2	12.1	15.0
28	*Alpinia zerumbet* 'Variegata'	4.4	5.9	4.2	4.1	5.3	3.6	5.3	0.3	0.5	10.7	5.3	7.7	4.3	8.2	4.2	7.4	6.6	4.2	3.6	7.1	5.3	4.6	4.7	5.2
29	*Dieffenbachia amoena*	19.6	16.1	15.2	16.1	22.1	23.5	15.1	14.6	26.9	18.6	18.0	18.1	18.2	18.7	19.1	10.9	19.8	12.8	17.4	11.8	15.1	16.8	19.6	15.4
30	*Dracaena* 'Purple Compacta'	4.1	3.8	4.0	4.1	3.7	5.7	5.1	4.9	5.2	4.8	4.9	5.7	5.8	5.7	4.0	5.9	4.7	5.0	4.6	5.4	4.3	2.1	3.8	2.5
31	*Dracaena marginata*	7.1	8.8	8.3	11.4	11.1	12.3	11.4	6.8	9.7	12.1	11.6	9.2	15.1	8.5	12.6	13.3	18.7	9.7	12.9	11.3	11.2	10.6	10.8	12.3
32	*Dracaena sanderiana*	4.0	4.5	3.7	3.5	4.0	5.5	5.1	6.4	7.0	6.4	6.4	8.2	6.9	7.2	8.6	6.8	8.5	8.7	7.6	7.1	8.8	7.3	8.2	7.4
33	*Nephrolepis exaltata*	16.1	8.7	19.0	11.7	13.7	12.0	20.7	21.0	42.0	14.8	38.2	24.4	32.9	24.2	39.7	23.5	31.7	23.7	42.5	35.7	41.5	41.0	41.9	33.2
34	*Peperomia clusiifolia*	0.3	0.3	0.3	0.3	0.2	0.9	0.3	0.2	0.2	0.3	0.3	0.5	0.2	0.3	0.6	0.3	0.3	0.3	0.3	0.6	0.4	0.3	0.7	0.4
35	*Peperomia obtusifolia* 'Sensation'	1.5	1.7	1.0	1.3	1.5	1.4	0.8	1.0	0.9	1.2	1.1	1.9	1.0	1.8	1.3	0.9	1.2	2.0	1.8	1.6	1.8	1.6	1.3	1.5
36	*Pleomele reflexa*	0.4	0.2	0.5	0.4	0.2	0.3	0.4	0.5	0.3	0.9	0.5	0.6	1.3	0.8	1.2	0.5	0.6	0.8	0.7	1.1	0.8	0.7	0.8	0.6
37	*Sansevieria trifasciata* 'Hahnii'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	*Sansevieria trifasciata* 'Laurentii'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	*Zamioculcas zamiifolia*	0.2	0.2	0.4	0.3	0.3	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
CD (0.05)	*Species*	0.35**		0.27**		0.3**		0.21**		0.16**		0.34**		0.31**		0.37**		0.39**		0.27**		0.23**		0.23**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		0.16**		NS**		NS**		NS**	
	Species x Systems	NS**		NS**		NS**		0.29**		0.23**		0.48**		0.43**		0.52**		0.55**		0.38**		NS**		0.33**	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	5.2	6.0	3.7	5.8	4.4	7.4	6.9	9.4	6.3	8.3	5.9	7.9	6.4	7.6	9.1	9.3	7.1	7.9	1.7	6.5	5.7	7.6	6.7	6.5
41	*Cyperus alternifolius*	56.1	46.6	44.8	52.6	35.2	57.2	72.8	77.7	55.4	76.6	85.2	59.8	77.7	69.1	81.2	79.5	72.3	70.0	72.0	72.3	66.0	91.4	72.9	85.2
42	*Ophiopogon jaburan**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	*Ophiopogon jaburan* 'Variegata'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	*Scirpus cernuus**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CD (0.05)	*Species*	0.33**		0.43**		0.98**		0.76**		0.76**		0.69**		0.51**		0.59**		0.56**		0.25**		0.39**		0.31**	
	Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Climbing & Trailing																								
45	*Asparagus setaceus*	7.7	3.0	7.7	2.8	3.2	2.3	1.1	1.8	2.4	2.9	2.2	3.0	2.9	2.3	3.0	1.8	2.4	2.5	1.7	2.8	1.9	2.5	2.0	3.1
46	*Philodendron* 'Ceylon Gold'	16.7	11.6	10.0	11.7	11.6	10.5	11.4	10.9	11.1	9.8	13.1	11.0	15.8	13.5	15.2	14.0	19.2	15.9	17.6	12.3	20.5	13.7	18.7	12.9
47	*Philodendron elegans*	8.7	19.1	22.4	15.5	17.2	20.0	22.4	17.6	17.1	17.6	31.8	11.7	28.6	17.1	22.3	16.2	22.9	13.7	23.6	19.2	19.5	14.5	21.3	26.2
48	*Scindapsus aureus*	5.2	4.2	5.1	3.9	5.8	4.4	6.3	5.1	5.4	4.4	4.9	7.3	5.2	9.6	9.1	5.1	10.4	7.6	5.7	6.0	6.7	8.7	5.9	7.6
49	*Syngonium podophyllum*	7.7	9.2	7.0	12.0	9.4	15.0	8.4	10.6	5.7	12.1	17.3	13.9	7.7	14.3	15.0	12.3	18.4	13.8	18.1	15.3	13.9	14.5	18.9	15.6
50	*Syngonium wendlandii*	10.6	7.6	7.3	8.1	10.0	9.2	6.4	6.8	7.9	10.0	10.1	11.8	9.3	8.8	13.3	8.7	6.1	10.4	13.2	7.4	12.7	7.8	8.6	8.2
CD (0.05)	*Species*	0.44**		0.49**		0.73**		0.4**		0.32**		0.38**		0.46**		0.46**		0.28**		0.23**		0.18**		0.22**	
	Systems	NS**		NS**		NS**		NS**		NS**		0.22**		NS**		0.26**		0.16**		0.13**		0.1**		NS**	
	Species x Systems	0.63**		NS**		NS**		NS**		NS**		0.53**		0.65**		NS**		0.4**		0.32**		0.25**		0.32**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants with no petiole

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

minimum petiole girth respectively. The interaction effects produced significant results only during few months. *Philodendron wendlandii* (3.1 cm) in OV had the maximum girth, particularly in 11th month it was on par with the same in FP (3.0 cm) and *Anthurium crystallinum* (2.7 cm) in OV. The combinations which gave the minimum girth were *Begonia rex* in OV (0.7 cm) and FP (0.9 cm) which were on par with each other.

When tree-like plants were compared, *Chrysalidocarpus lutescens* stayed ahead of other species throughout the year for petiole girth and *Ficus benjamina* remained at the bottom. The plants kept in FP were found to have more girth than the plants in OV throughout the year. Coming to interaction effects, during the final stage, *Licuala grandis* kept in OV (3.2 cm) was observed with the highest girth and the lowest was in *Ficus benjamina* (0.4 cm) OV.

Among the flowering plants, the thickest petiole was observed in *Tacca chantrieri* throughout the year and it was on par with all other species in one or the other months except in *Anthurium andreanum* 'Bonina' which recorded having the thinnest petiole. FP produced thicker petiole than OV, but only during 2nd, 4th and 8th months. From the interaction effect, the combinations were significantly different only during few months, in particular during the last month, when *Kalanchoe blossfeldiana* had the maximum girth of 2.1 cm in FP which was on par with *Chrysothemis pulchella* (1.9 cm), *Spathiphyllum wallisii* (2 cm) and *Tacca chantrieri* (2cm) in OV. The lowest petiole girth was recorded in *Anthurium andreanum* 'Bonina' in FP (1.2 cm) and it was on par with the same species in OV (1.3 cm), and *Costus curvibracteatus* in both the systems (1.3 and 1.2 cm).

When the upright plant species were concerned, the highest petiole girth was recorded in *Dieffenbachia amoena* throughout the year. The lowest girth was recorded in different species during the course of the period. However, during the year end; it was *Nephrolepis exaltata* and *Peperomia obtusifolia* 'Sensation' was on par with that. The growing systems were significantly different only during the third and eighth months, during which plants in FP had thicker petiole than the other. The interaction effects produced significant results throughout the year except during seventh month. During the final month, *Dieffenbachia amoena* in both systems OV (3.3 cm) and FP (3.5 cm) had the maximum petiole girth; *Nephrolepis exaltata* in both systems (1.0 and 0.9 cm), *Peperomia obtusifolia* 'Sensation' in OV (1.0 cm) and *Zamioculcas zamiifolia* in FP (1.1 cm) had the minimum girth and they were on par.

Table 10: Petiole girth of foliage plants in two growing systems in different months

S. No.	Plant species	Plant girth (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette																								
1	*Anthurium crystallinum*	1.9	1.4	1.7	1.5	1.7	1.8	2.0	1.5	2.4	2.0	2.2	1.6	2.5	2.6	2.5	1.8	1.7	2.3	2.8	2.0	2.7	1.8	2.7	2.1
2	*Begonia rex*	1.1	0.9	1.0	1.1	1.0	1.2	0.8	1.1	1.1	0.8	1.0	0.7	0.8	0.9	0.9	0.9	0.9	0.9	0.9	1.1	0.7	0.9	0.9	0.8
3	*Calathea ornata* 'Roseo-lineata'	1.4	0.9	1.2	1.2	0.9	1.3	1.0	1.1	1.4	1.2	1.3	1.3	1.1	1.4	1.3	1.5	1.3	1.4	1.4	1.4	1.4	1.4	1.3	1.3
4	*Calathea zebrina*	1.8	1.4	1.6	1.4	1.1	1.4	1.3	1.4	1.6	1.7	1.8	1.6	1.6	2.0	1.2	1.7	1.5	1.7	1.5	1.4	1.5	1.7	1.5	1.5
5	*Homalomena wallisii*	1.2	1.3	1.4	1.2	1.1	1.7	1.4	1.4	1.5	1.5	1.6	1.6	1.1	1.2	1.6	1.5	1.1	1.4	1.2	1.5	1.5	1.3	1.3	1.2
6	*Philodendron wendlandii*	1.4	2.1	2.3	2.0	2.5	2.7	2.8	2.2	3.1	2.2	2.6	2.1	2.5	2.7	2.9	3.0	2.8	2.9	3.0	3.0	3.1	3.0	3.1	3.1
7	*Rhoeo discolor**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	*Tillandsia stricta**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	*Tradescantia spathacea* 'Sitara'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CD (0.05)	*Species*	0.09**		0.07**		0.12**		0.08**		0.11**		0.07**		0.12**		0.08**		0.09**		0.07**		0.09**		0.07**	
	Systems	NS**		NS**		0.06**		NS**		0.06**		0.04**		NS**		NS**		0.05**		NS**		NS**		NS**	
	Species x Systems	0.13**		NS**		NS**		0.12**		NS**		NS**		NS**		0.12**		NS**		0.1**		0.12**		NS**	
	Tree like																								
10	*Chrysalidocarpus lutescens*	1.2	1.7	1.3	1.6	1.1	1.7	1.7	1.7	1.7	1.9	2.4	2.0	2.0	2.0	2.1	1.9	2.3	2.4	3.0	2.3	2.7	2.4	2.5	2.5
11	*Codiaeum variegatum* 'Delaware'	0.7	0.9	0.9	1.1	0.5	1.1	0.9	1.0	1.1	1.2	1.0	1.1	1.0	1.4	1.1	1.4	1.1	1.3	1.0	1.1	1.1	0.9	1.1	1.0
12	*Codiaeum variegatum* 'Punctatum aureum'	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.3	0.5	0.4	0.4	0.4	0.6	0.6	0.6	0.6	0.6	0.5	0.5
13	*Ficus benjamina*	0.2	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.5
14	*Licuala grandis*	0.8	0.9	1.1	0.9	1.4	1.3	1.1	1.2	1.7	1.7	1.4	1.3	1.6	1.5	1.9	1.9	1.8	1.7	1.8	2.0	1.7	1.5	3.2	1.6
15	*Polyscias guilfoylei*	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.6	0.7	0.6	0.8	0.6	1.0	0.7	0.9	0.5	0.9
16	*Polyscias paniculata* 'Variegata'	0.7	0.6	0.7	0.7	0.8	0.7	0.7	0.6	0.6	0.6	0.7	0.8	0.8	0.9	0.7	0.8	0.7	0.7	0.8	1.0	0.6	1.1	0.8	1.0
17	*Rhapis excelsa*	0.4	0.3	0.4	0.7	0.3	0.7	0.4	0.5	0.4	0.7	0.4	1.0	0.4	1.0	0.9	0.8	0.6	0.9	0.8	1.0	0.9	1.5	0.6	1.2
18	*Schefflera arboricola*	0.5	0.6	0.4	0.5	0.5	0.4	0.5	0.5	0.4	0.7	0.4	0.5	0.5	0.6	0.4	0.7	0.6	0.6	0.5	0.7	0.6	1.7	0.6	1.5
CD (0.05)	*Species*	0.06**		0.05**		0.07**		0.05**		0.08**		0.06**		0.07**		0.06**		0.07**		0.07**		0.04**		0.04**	
	Systems	NS**		0.02**		0.03**		NS**		0.03**		0.02**		0.03**		0.03**		0.03**		0.03**		0.02**		0.02**	
	Species x Systems	0.08**		0.08**		0.11**		NS**		NS**		0.08**		0.1**		0.09**		NS**		0.09**		0.07**		0.06**	
	Flowering																								
19	*Anthurium andreanum 'Bonina'*	1.0	1.0	0.8	1.1	0.9	1.4	1.0	1.1	1.3	1.2	1.3	1.1	1.3	1.3	1.3	1.6	1.1	1.4	1.1	1.4	1.4	1.3	1.3	1.2
20	*Chrysothemis pulchella*	1.0	1.6	0.7	1.9	0.4	0.6	1.6	1.7	1.4	1.2	1.1	1.3	0.6	1.4	1.1	1.3	0.8	1.1	1.6	1.1	1.2	1.7	1.9	1.8
21	*Costus curvibracteatus*	1.0	1.2	0.9	1.3	1.2	0.4	1.4	1.8	1.1	1.7	1.1	1.1	1.3	0.7	1.5	1.7	1.0	1.1	1.2	1.3	1.4	1.4	1.3	1.2
22	*Iris innominata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*Kalanchoe blossfeldiana*	1.1	1.2	1.3	1.2	0.9	1.5	1.2	1.4	1.2	1.4	1.7	1.9	1.7	1.8	1.6	2.4	2.0	1.9	1.9	1.8	1.9	2.0	1.5	2.1
24	*Spathiphyllum wallisii*	1.9	1.4	1.7	1.5	1.7	1.7	1.6	1.9	2.0	1.8	1.7	1.5	1.8	2.0	1.6	1.8	1.9	1.7	1.8	1.7	1.8	1.8	2.0	1.5
25	*Tacca chantrieri*	1.6	1.5	1.8	1.6	1.4	1.7	1.7	1.7	2.3	2.0	2.0	1.8	2.2	2.0	2.3	2.6	2.0	2.0	2.2	2.0	2.0	1.7	2.0	1.8
CD (0.05)	*Species*	0.1**		0.08**		0.09**		0.08**		0.14**		0.06**		0.08**		0.11**		0.08**		0.08**		0.07**		0.06**	
	Systems	NS**		0.04**		NS**		0.05**		NS**		NS**		NS**		0.06**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		0.12**		0.13**		NS**		NS**		NS**		0.12**		NS**		NS**		0.11**		NS**		0.09**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants with no petiole

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

Table 10: Petiole girth of foliage plants in two growing systems in different months (Contd.,)

S. No.	Plant species	Plant girth (cm)																							
		Months after planting																							
		1		2		3		4		5		6		7		8		9		10		11		12	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Upright																								
26	*Aglaonema nitidum* 'Curtisii'	1.5	2.1	1.7	2.3	1.8	2.1	2.4	2.5	2.5	2.1	2.6	2.2	2.2	1.8	1.9	2.2	2.1	2.0	2.1	2.5	2.0	1.9	2.3	1.9
27	*Aglaonema pseudobracteatum*	1.4	1.6	1.6	1.6	1.5	1.7	1.4	1.9	1.8	1.8	1.7	1.5	1.7	1.5	1.3	1.5	1.8	1.6	1.5	1.7	1.7	1.6	1.5	1.5
28	*Alpinia zerumbet* 'Variegata'	2.0	1.3	1.6	1.5	1.5	1.5	1.5	1.5	1.6	1.5	1.5	1.4	1.5	1.7	1.7	1.9	1.2	1.9	1.9	1.7	1.9	1.7	1.6	1.6
29	*Dieffenbachia amoena*	2.9	2.9	2.5	2.9	3.0	3.5	3.5	2.9	2.6	3.1	3.0	2.8	3.1	3.2	3.2	3.1	3.3	3.2	3.1	3.0	3.7	3.7	3.3	3.5
30	*Dracaena* 'Purple Compacta'	1.2	1.7	1.1	1.3	1.5	2.4	1.8	1.7	1.8	2.1	2.3	1.9	1.8	2.3	2.0	2.1	1.6	1.9	1.5	1.9	1.4	2.2	1.7	2.3
31	*Dracaena marginata*	1.1	1.4	1.5	1.6	1.6	1.3	1.7	1.9	1.7	1.6	2.3	1.5	1.9	1.8	2.8	2.0	2.7	1.9	2.7	1.6	2.3	1.6	2.0	1.5
32	*Dracaena sanderiana*	0.7	1.8	1.3	1.7	2.0	2.2	2.0	2.0	2.3	2.1	2.6	1.9	1.9	1.7	1.8	2.3	1.9	2.1	1.8	2.0	1.9	2.1	1.8	2.2
33	*Nephrolepis exaltata*	0.9	1.0	0.9	0.8	1.1	0.9	1.1	0.9	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.2	1.0	1.2	1.2	0.9	1.2	1.2	1.0	0.9
34	*Peperomia clusiifolia*	0.5	0.4	0.4	0.8	0.3	0.6	0.6	0.6	0.4	0.7	1.2	0.6	0.5	0.6	1.1	1.2	1.0	1.3	1.7	1.8	1.9	1.7	2.0	1.5
35	*Peperomia obtusifolia* 'Sensation'	1.0	0.9	1.0	0.9	1.0	0.9	0.7	1.1	1.0	1.3	1.0	1.3	0.9	1.5	1.1	1.1	1.0	1.5	1.2	1.3	1.2	1.3	1.0	1.2
36	*Pleomele reflexa*	1.3	0.7	1.8	0.5	0.8	1.9	1.7	2.2	1.8	2.2	2.0	2.0	1.9	2.5	1.7	2.2	2.3	1.6	2.3	1.8	2.1	1.7	1.8	2.0
37	*Sansevieria trifasciata* 'Hahnii'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	*Sansevieria trifasciata* 'Laurentii'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	*Zamioculcas zamiifolia*	0.4	0.3	0.6	0.4	0.4	0.5	0.5	0.8	0.4	1.0	0.6	0.7	0.4	0.6	0.5	0.9	0.7	0.8	1.1	0.9	1.0	1.3	1.3	1.1
	Species	0.08**		0.09**		0.07**		0.07**		0.08**		0.07**		0.1**		0.09**		0.08**		0.09**		0.07**		0.08**	
CD (0.05)	*Systems*	NS**		NS**		0.03**		0.02**		0.03**		0.02**		0.04**		0.03**		NS**		NS**		NS**		NS**	
	Species x Systems	0.11**		0.12**		0.11**		0.1**		0.12**		0.1**		NS**		0.12**		0.12**		0.13**		0.03**		0.11**	
	Grass like																								
40	*Chlorophytum* 'Charlotte'	1.0	1.2	1.1	1.6	1.2	1.4	1.8	1.8	1.8	1.9	1.5	1.7	1.5	1.5	1.3	1.1	1.3	1.8	1.4	1.0	2.2	1.1	1.3	1.2
41	*Cyperus alternifolius*	1.4	1.3	1.2	1.7	1.6	1.8	1.4	1.8	1.3	1.8	1.9	2.0	1.9	1.9	2.0	1.9	2.2	1.7	1.9	1.9	1.7	1.8	1.6	2.0
42	*Ophiopogon jaburan**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	*Ophiopogon jaburan* 'Variegata'*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	*Scirpus cernuus**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Species	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
CD (0.05)	*Systems*	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**		NS**	
	Climbing & Trailing																								
45	*Asparagus setaceus*	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.5	0.4	0.7	0.5	0.6
46	*Philodendron* 'Ceylon Gold'	1.6	1.2	1.2	1.9	1.5	1.9	1.8	1.9	2.0	1.9	2.2	1.8	2.0	2.0	2.3	2.0	2.3	2.5	2.3	2.3	2.5	2.3	2.3	2.4
47	*Philodendron elegans*	2.0	2.7	2.4	1.7	1.8	2.2	2.4	2.4	2.1	2.2	2.7	1.8	2.2	2.6	1.6	1.9	1.8	1.9	2.1	2.3	2.0	2.1	2.0	2.3
48	*Scindapsus aureus*	1.0	1.1	1.1	0.9	0.9	1.0	1.5	1.0	1.6	1.3	1.5	1.4	5.6	1.4	1.7	1.6	1.5	1.2	1.3	1.4	1.3	1.4	1.3	1.2
49	*Syngonium podophyllum*	0.7	0.6	0.7	1.0	0.8	1.0	0.4	1.2	0.6	1.3	1.2	0.9	0.6	1.1	1.2	1.2	1.1	1.0	1.1	1.2	1.2	1.2	0.9	1.1
50	*Syngonium wendlandii*	0.8	0.7	0.7	0.8	0.6	0.7	0.5	0.9	1.0	0.7	1.1	0.7	0.9	0.9	0.8	0.7	0.9	0.7	1.0	0.9	0.8	0.7	0.9	0.8
	Species	0.13**		0.09**		0.09**		0.07**		0.07**		0.05**		0.51**		0.09**		0.08**		0.05**		0.05**		0.06**	
CD (0.05)	*Systems*	NS**		NS**		0.05**		0.04**		NS**		0.03**		NS**		NS**		NS**		NS**		NS**		NS**	
	Species x Systems	NS**		0.13**		NS**		0.09**		0.1**		0.08**		NS**		NS**		NS**		NS**		0.08**		NS**	

OV-Open ventilated greenhouse, FP- Fan and pad greenhouse

*Plants with no petiole

**CD value obtained from data subjected to square root transformation

NS-Non-significant at 5% level

There were only two species in grass-like plants that had petiole. They were *Chlorophytum* 'Charlotte' and *Cyperus alternifolius* and there was no significant difference between them at any level.

Among climbing & trailing plants, *Philodendron elegans* had the thickest petiole for most of the months and during the remaining months it was *Philodendron* 'Ceylon Gold'. The growing systems differed significantly only during the initial months. The combination effects produced significantly different results only during the second, fourth, fifth, sixth and eleventh months. No combinations had the maximum significant value. The minimum girth was observed in *Asparagus setaceus* kept in OV.

4.1.1.1.8. Leaf producing interval (days) (Phyllochron)

Leaf producing interval of foliage plants was significantly different between the species except among the plants with grass-like growth habit. The different growing systems and their interaction with species also had no significant effect on leaf producing interval except the plants with upright growth which produced leaves at shorter intervals in OV than in FP. The data are presented in the Table 11.

In rosette type, *Rhoeo discolour* produced leaves at shorter intervals and it was on par with *Begonia rex*, *Tillandsia stricta* and *Tradescantia spathacea* 'Sitara'. *Anthurium crystallinum* produced leaves at longer interval. *Codiaeum variegatum* 'Punctatum aureum' and *Chrysalidocarpus lutescens* were the species in tree-like plants that produced leaves at shorter and longer intervals respectively. Among flowering plants, leaf producing interval of *Kalanchoe blossfeldiana* was the shortest, *Chrysothemis pulchella* was at par and *Anthurium andreanum* 'Bonina' was the longest. In upright type plants, the species which produced leaves at shorter interval was *Pleomele reflexa* and it was on par with *Peperomia obtusifolia* 'Sensation', *Aglaonema nitidum* 'Curtisii', *Dracaena* 'Purple Compacta' and *D. marginata*. *Sansevieria trifasciata* 'Hahnii' and *S. trifasciata* 'Laurentii' produced leaves at longer intervals. Among climbing and trailing type, *Scindapsus aureus* and *Syngonium podophyllum* were the species that produced leaves at shorter intervals and *Philodendron* 'Ceylon Gold' at longer intervals.

4.1.1.1.9. Leaf longevity (days)

There was a significant difference between the foliage plants in keeping the leaves intact for more number of days. But there was no significantly different result between the growing systems and its interaction effects with species (Table 11).

Among rosette growth type of plants, *Tillandsia stricta* had the highest leaf longevity and the lowest was in *Begonia rex* and *Calathea ornata* 'Roseo-lineata'. *Rhapis excelsa* retained the leaves for more days in tree-like plants and *Ficus benjamina* the least. It was on par with *Polyscias paniculata* 'Variegata' and *Codiaeum variegatum* 'Delaware'. In flowering plants, *Spathiphyllum wallisii* and *Chrysothemis pulchella* had the highest and the lowest leaf longevity respectively. Among upright plants, *Sansevieria trifasciata* 'Hahnii' and *S. trifasciata* 'Laurentii' had the highest leaf longevity of more than a year in both the systems and the lowest was recorded in *Dracaena* 'Purple Compacta', *Aglaonema nitidum* 'Curtisii', *Alpinia zerumbet* 'Variegata' and *Nephrolepis exaltata*, all being at par. *Ophiopogon jaburan* and *O. jaburan* 'Variegata' were the species that had the highest leaf longevity among grass-like species and the lowest was recorded in *Chlorophytum* 'Charlotte' and *Scirpus cernuus*. In climbing and trailing type, the highest and the lowest leaf longevity were recorded in *Scindapsus aureus* and *Syngonium wendlandii* respectively.

4.1.1.1.10. Number of tillers

Number of tillers/suckers is important because of its economic value as a propagating material. With regard to the foliage plants, most of the species produced tillers and they significantly differed with each other in this character. In comparison between systems and its interaction with species, there was no significant result except among upright plants where OV produced more tillers than FP. In climbing and trailing type, *Asparagus setaceus* was the only plant which had side shoots and in tree-like plants, tillers were produced only by *Chrysalidocarpus lutescens* and *Rhapis excelsa*. Among rosette type, *Rhoeo discolour* and *Tradescantia spathacea* 'Sitara' had the highest number of tillers and *Tillandsia stricta* had the lowest. *Costus curvibracteatus* was the species in flowering plants that had more number of tillers and the least was in *Spathiphyllum wallisii* and it was on par with *Tacca chantrieri*. Among upright plants, the highest numbers of tillers were produced in *Nephrolepis exaltata*, which was on par with *Alpinia zerumbet* 'Variegata' and *Sansevieria trifasciata* 'Hahnii'. The lowest number of tillers was recorded in *Peperomia clusiifolia* and *Pleomele reflexa*.

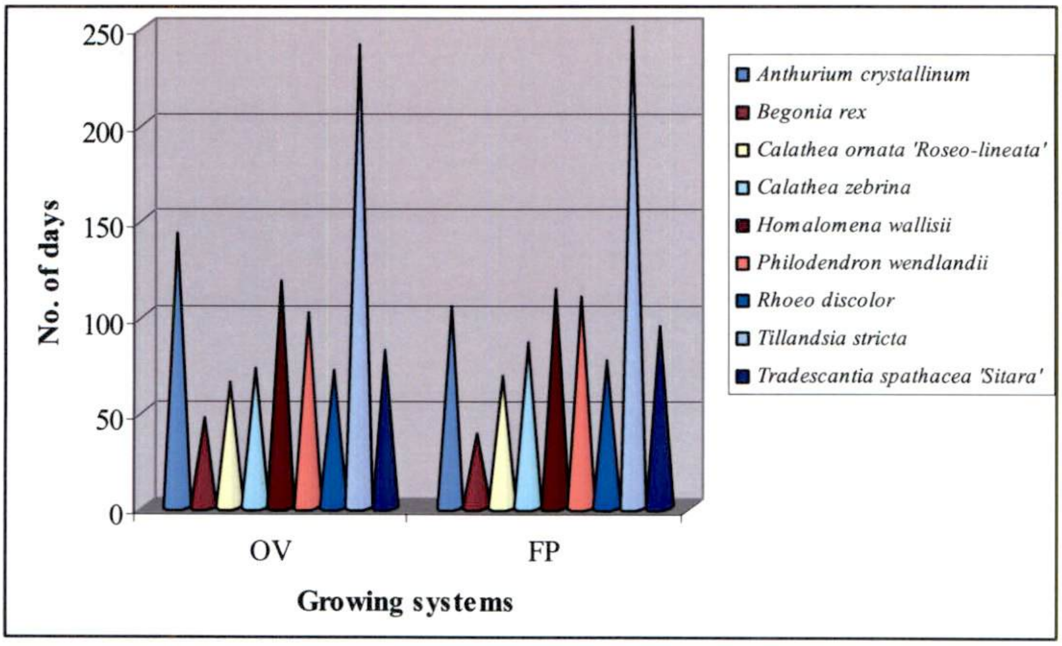
Table 11: Leaf producing interval, leaf longevity and number of tillers of foliage plants in the two growing systems

S. No.	Plant species	Leaf producing interval (days)		Leaf longevity (days)		No. of tillers	
		OV	FP	OV	FP	OV	FP
	Rosette						
1	*Anthurium crystallinum**	71.4	62.3	142.7	104.7	-	-
2	*Begonia rex**	12.6	14.3	46.3	38.0	-	-
3	*Calathea ornata* 'Roseo-lineata'	35.3	39.8	65.3	68.0	5.7	5.3
4	*Calathea zebrina*	47.8	22.0	72.0	85.3	6.3	6.3
5	*Homalomena wallisii**	23.1	22.1	117.3	113.3	-	-
6	*Philodendron wendlandii**	36.1	28.8	101.7	109.7	-	-
7	*Rhoeo discolor*	8.3	10.0	71.7	76.3	9.0	9.3
8	*Tillandsia stricta*	15.2	15.3	240.0	249.3	2.3	2.7
9	*Tradescantia spathacea* 'Sitara'	9.0	10.5	82.0	93.7	8.3	7.7
CD (0.05)	*Species*	0.92**		27.56		0.26**	
	Systems	NS**		NS		NS**	
	Species x *Systems*	NS**		NS		NS**	
	Tree like						
10	*Chrysalidocarpus lutescens*	68.4	57.3	187.0	157.7	1.7	1.3
11	*Codiaeum variegatum* 'Delaware'*	31.7	39.9	142.3	86.0	-	-
12	*Codiaeum variegatum* 'Punctatum aurcum'*	7.7	7.6	149.7	151.0	-	-
13	*Ficus benjamina**	16.7	15.4	63.7	87.7	-	-
14	*Licuala grandis**	47.9	44.4	252.0	230.7	-	-
15	*Polyscias guilfoylei* 'Quinquefolia'*	11.7	15.7	136.7	146.3	-	-
16	*Polyscias paniculata* 'Variegata'*	13.1	18.2	80.0	77.7	-	-
17	*Rhapis excelsa*	47.8	44.3	302.7	301.0	2.0	1.7
18	*Schefflera arboricola**	11.4	13.0	160.0	168.3	-	-
CD (0.05)	*Species*	0.65**		43.29		NS**	
	Systems	NS**		NS		NS**	
	Species x *Systems*	NS**		NS		NS**	
	Flowering						
19	*Anthurium andreanum* 'Bonina'*	50.2	57.0	125.3	104.0	-	-
20	*Chrysothemis pulchella*	12.9	20.6	32.3	32.0	4.0	5.0
21	*Costus curvibracteatus*	21.1	19.7	75.0	72.3	22.3	19.7
22	*Iris innominata*	40.0	41.8	121.3	128.7	4.3	4.7
23	*Kalanchoe blossfeldiana*	11.4	10.4	53.7	64.7	6.0	7.0
24	*Spathiphyllum wallisii*	35.7	31.1	155.3	159.7	2.3	2.0
25	*Tacca chantrieri*	23.9	28.9	106.3	103.7	2.7	2.3
CD (0.05)	*Species*	0.84		22.72		0.37**	
	Systems	NS		NS		NS**	
	Species x *Systems*	NS		NS		NS**	
	Upright						
26	*Aglaonema nitidum* 'Curtisii'	16.6	19.3	98.0	93.3	4.3	4.0
27	*Aglaonema pseudobracteatum*	23.0	25.3	142.7	96.3	4.3	2.7
28	*Alpinia zerumbet* 'Variegata'	23.2	22.1	83.0	101.0	5.7	4.3
29	*Dieffenbachia amoena**	33.0	32.4	124.3	113.0	-	-
30	*Dracaena* 'Purple Compacta'*	11.0	14.2	62.7	92.0	-	-
31	*Dracaena marginata**	14.7	14.3	138.7	142.3	-	-
32	*Dracaena sanderiana*	19.6	24.4	244.3	267.3	4.3	2.3
33	*Nephrolepis exaltata*	16.7	22.1	72.3	67.7	6.7	6.3
34	*Peperomia clusiifolia*	21.3	42.0	137.3	148.0	2.3	2.0

Table 11: Leaf producing interval, leaf longevity and number of tillers of foliage plants in the two growing systems (Contd.,)

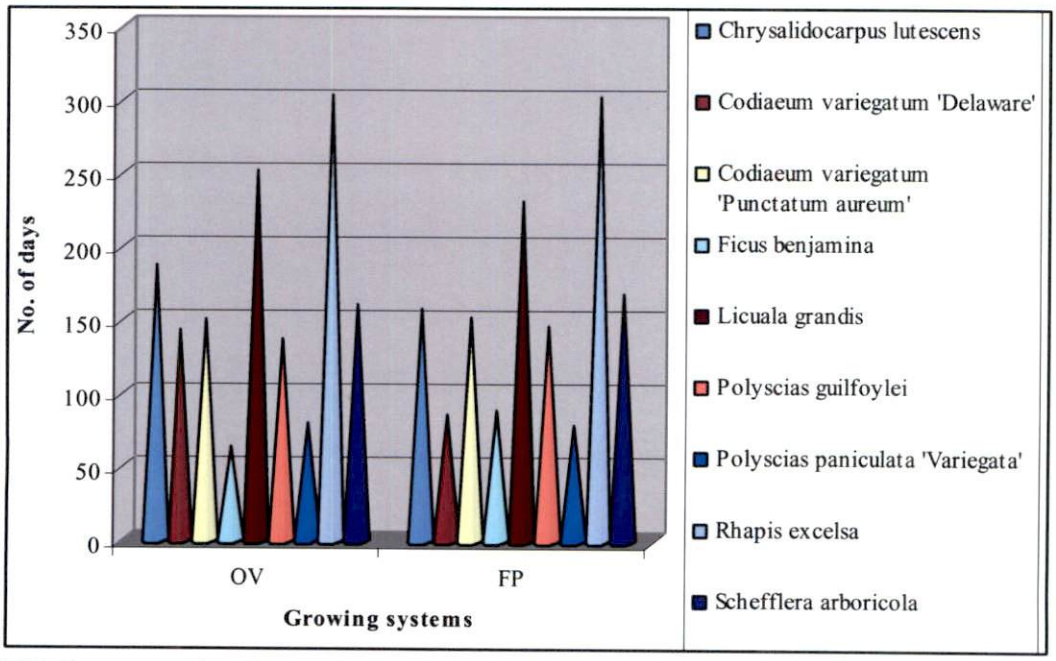
S. No.	Plant species	Leaf producing interval (days)		Leaf longevity (days)		No. of tillers	
		OV	FP	OV	FP	OV	FP
35	*Peperomia obtusifolia* 'Sensation'	12.8	16.1	263.0	285.3	5.0	4.7
36	*Pleomele reflexa*	8.6	11.9	147.3	135.0	1.7	1.3
37	*Sansevieria trifasciata* 'Hahnii'#	45.5	67.8	365.0	365.0	6.3	5.3
38	*Sansevieria trifasciata* 'Laurentii'#	63.9	67.0	365.0	365.0	4.7	4.0
39	*Zamioculcas zamiifolia*	0.0	0.0	191.3	223.0	5.0	4.7
CD (0.05)	*Species*	1.08**		33.69		0.32**	
	Systems	0.42**		NS		0.13**	
	Species x *Systems*	NS**		NS		NS**	
	Grass like						
40	*Chlorophytum* 'Charlotte'	13.6	14.2	60.7	61.0	5.3	3.3
41	*Cyperus alternifolius*	12.1	12.5	83.7	133.0	22.7	30.7
42	*Ophiopogon jaburan*	12.1	14.7	141.7	128.0	2.3	3.3
43	*Ophiopogon jaburan* 'Variegata'	11.9	12.6	102.7	139.7	2.3	2.7
44	*Scirpus cernuus*	9.0	10.1	63.3	57.0	6.0	4.7
CD (0.05)	*Species*	NS**		22.51		0.30**	
	Systems	NS**		NS		NS**	
	Species x *Systems*	NS**		NS		NS**	
	Climbing & Trailing						
45	*Asparagus setaceus*	32.0	26.5	73.7	80.0	6.3	5.7
46	*Philodendron* 'Ceylon Gold'*	56.1	40.6	96.3	111.7	-	-
47	*Philodendron elegans**	30.1	31.0	174.7	168.3	-	-
48	*Scindapsus aureus**	10.2	12.7	200.0	207.3	-	-
49	*Syngonium podophyllum**	13.0	18.2	70.0	70.3	-	-
50	*Syngonium wendlandii**	29.9	19.3	33.3	36.7	-	-
CD (0.05)	*Species*	1.03**		23.05		NS**	
	Systems	NS**		NS		NS**	
	Species x *Systems*	NS**		NS		NS**	

OV-Open ventilated greenhouse, FP- Fan & pad greenhouse
#Plants with leaf longevity more than a year (for analysis it is taken as 365 days)
*Plants with no tillers
**CD value obtained from data subjected to square root transformation
NS-Non-significant at 5% level



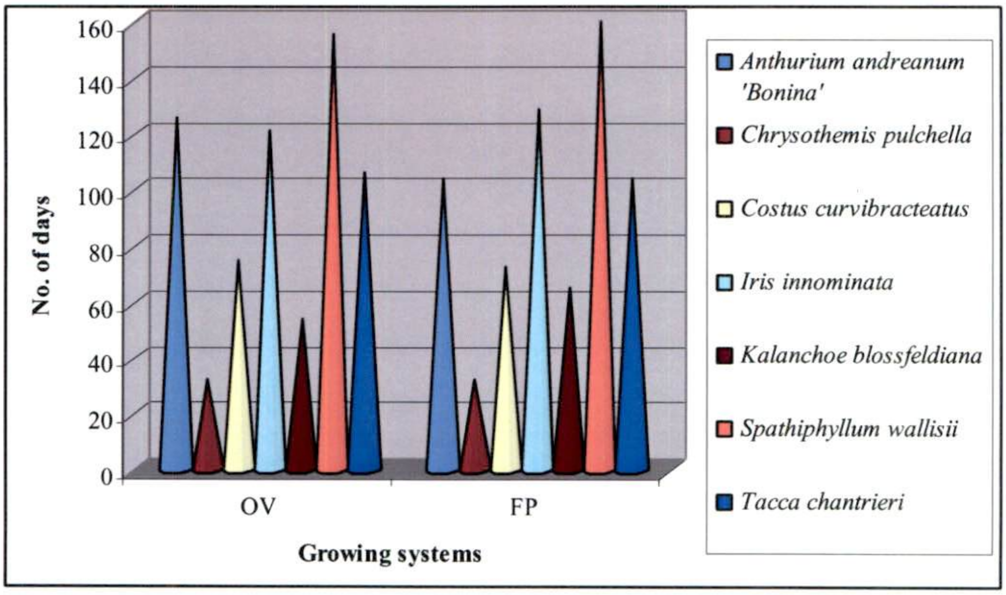
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 12. Leaf longevity of rosette type foliage plants in open ventilated and fan and pad greenhouses



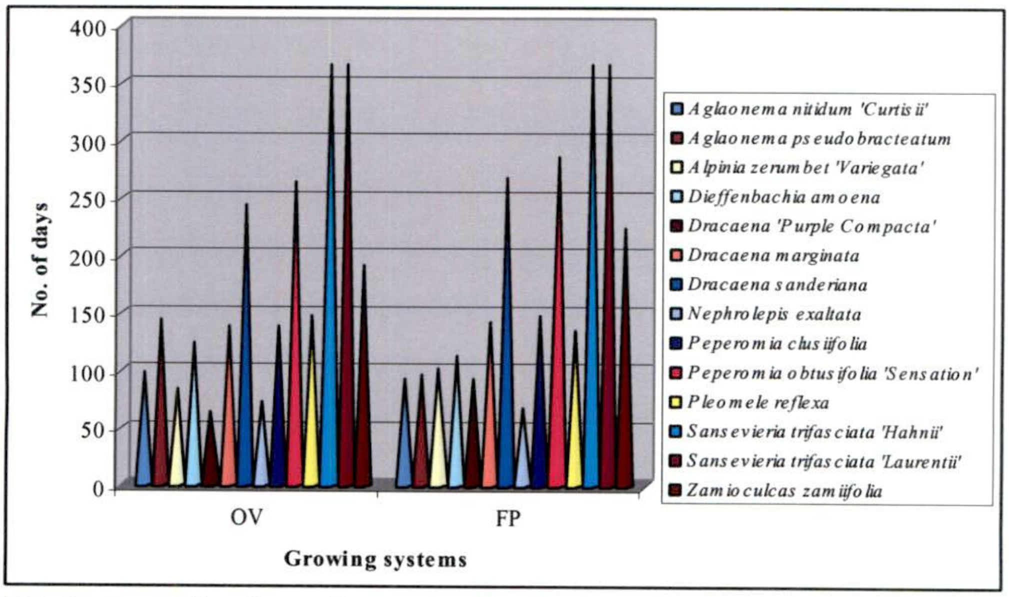
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 13. Leaf longevity of tree-like foliage plants in open ventilated and fan and pad greenhouses



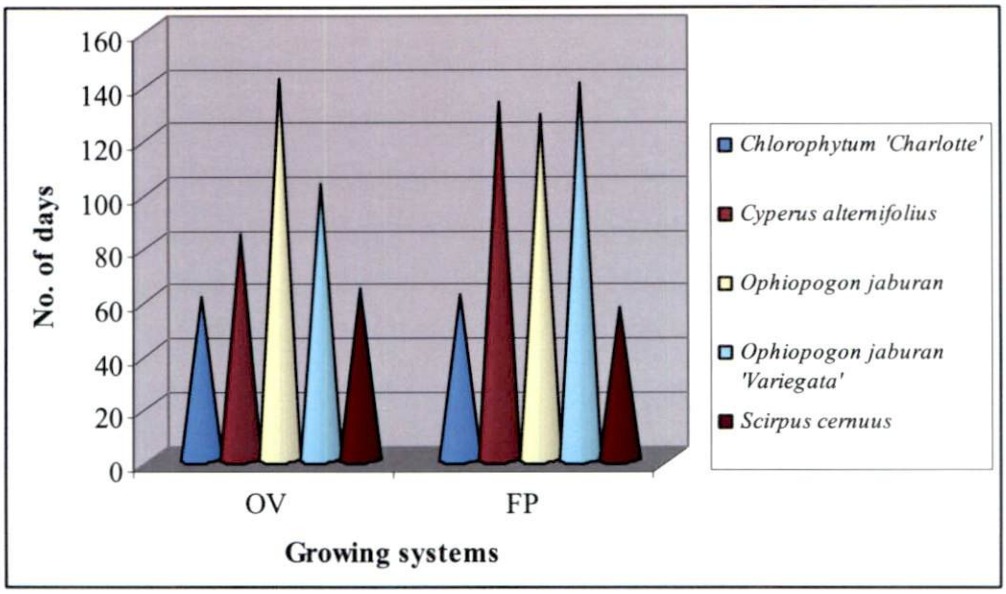
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 14. Leaf longevity of flowering foliage plants in open ventilated and fan and pad greenhouses



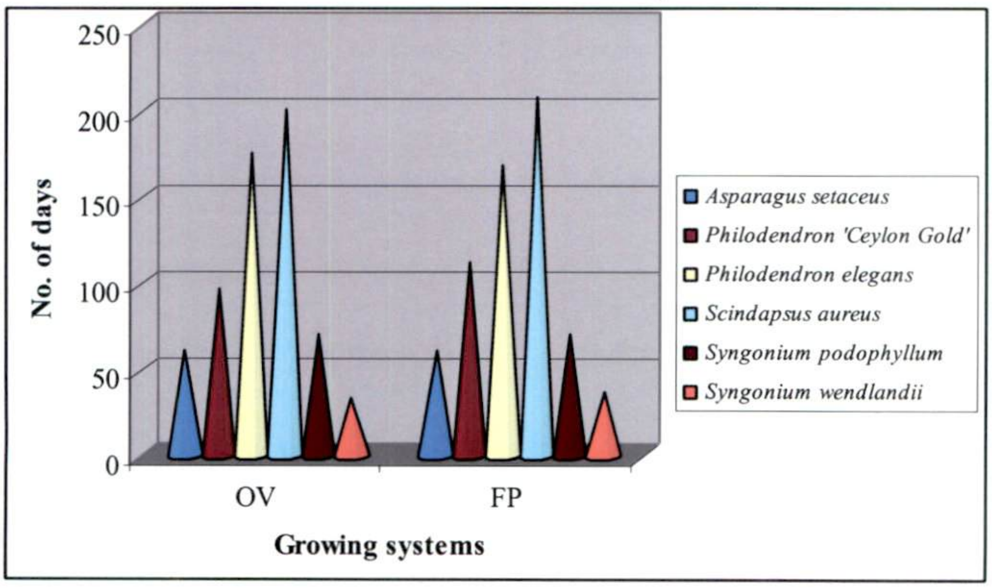
OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 15. Leaf longevity of upright foliage plants in open ventilated and fan and pad greenhouses



OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 16. Leaf longevity of grass-like foliage plants in open ventilated and fan and pad greenhouses



OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Fig 17. Leaf longevity of climbing and trailing foliage plants in open ventilated and fan and pad greenhouses

Cyperus alternifolius had the highest number of suckers among grass-like plants. Both *Ophiopogon jaburan* and *O. jaburan* 'Variegata' recorded the lowest among the type.

4.1.1.2. Qualitative characters

Leaf characters like texture, shape, margin, tip, base, type, pigmentation, venation and arrangement were observed and presented in Table 12.

4.1.1.3. Others

Branching habit, pests and diseases, other symptoms like bending, drooping etc were observed with regard to the two growing systems and presented in Table 13.

4.1.1.4. Plant quality rating

The quality rating of foliage plants was done based on five parameters namely growth and fullness (texture, shape and pattern), colour and pigmentation, suitability to indoor conditions (tolerance capacity), pests and diseases and other problems and APTI. All those parameters were scored out of ten and a total was obtained out of 50. Based on the scoring, the plants were ranked accordingly which was presented in the Table (14). In rosette type, *Anthurium crystallinum* scored high (37.66 points out of 50) which was closely followed by *Calathea zebrina* (35.23). *Begonia rex* (29.08) had the lowest score. Among tree-like plants, *Chrysalidocarpus lutescens* (38.14) with its high pests and diseases tolerance capacity (9.0) and growth and fullness (8.8), scored the highest and the lowest was *Polyscias paniculata* 'Variegata' (31.47). In flowering plants *Anthurium andreanum* 'Bonina' ranked first with a score of 44.50. *Iris innominata* had the last rank with a score 31.43. *Sansevieria trifasciata* 'Laurentii' (38.11) and *Peperomia clusiifolia* (32.36) had the highest and the lowest scorers respectively among upright plant type. In grass-like species, *Ophiopogon jaburan* 'Variegata' (34.76) was having the maximum score and the minimum was in *Cyperus alternifolius* (28.23). In climbing and trailing plants, the highest (37.77) and the lowest (29.18) scores were in *Scindapsus aureus* and *Syngonium wendlandii* respectively.

Plate 10. Pests and diseases of foliage plants observed in different growing systems

10.1. *Spodoptera litura* attack on *Anthurium andreanum* 'Bonina'

10.2. Snails attack on *Chrysothemis pulchella*

10.3. Aphids feeding on *Alpinia zerumbet* 'Variegata'

10.4. Collar rot in *Aglaonema nitidum* 'Curtisii'

10.5. Stem rot in *Peperomia clusiifolia*

10.6. Leaf spot in *Tacca chantrieri*

10.7. Stem and leaf rot in *Begonia rex*

10.8. Leaf rot in *Tradescantia spathacea* 'Sitara'

10.9. Collar rot in *Kalanchoe blossfeldiana*

10.10. Bacterial blight in *Chlorophytum* 'Charlotte'

10.11. *Pseudocercospora panacis* leaf spot in *Polyscias paniculata* 'Variegata'

10.12. Sheath rot in *Sansevieria trifasciata* 'Laurentii'

Table 12. Qualitative leaf characters of foliage plants selected for the study

S. No.	Plant species	Leaf characters								
		Texture	Shape	Margin	Tip	Base	Type	Venation	Arrangement	Pigmentation
	Rosette									
1	*Anthurium crystallinum*	Coarse	Cordate	Revolute	Acuminate	Cordate	Simple	Pinnate	Alternate	Glistening emerald green
2	*Begonia rex*	Medium	Ovate	Serrulate	Acute	Oblique	Simple	Palmate	Alternate	Green, red beneath
3	*Calathea ornata* 'Roseo-lineata'	Coarse	narrow-ovate	Entire	Acute	unequal-sided obtuse	Simple	Pinnate	Spiral	Metallic olive-green marked with closely-set pairs of rosy-red lateral strips, later turning white, purple beneath
4	*Calathea zebrina*	Coarse	Ovate	Entire	Acute	unequal-sided obtuse	Simple	Pinnate	Spiral	Deep velvety green, midrib and lateral veins pale or yellow-green, purplish beneath
5	*Homalomena wallisii*	Coarse	Ovate	Entire	acuminate	attenuate	Simple	Pinnate	Spiral	Dark olive green blotched with yellowish silver, translucent silvery edge
6	*Philodendron wendlandii*	Coarse	long Obovate	Entire	acute	auriculate	Simple	Pinnate	Spiral	Green and purple below in juvenile later turning light green
7	*Rhoeo discolor*	Medium	lanceolate	Entire	acute	rosette	Simple	parallel	Alternate	Metallic dark green, vivid glossy purple beneath
8	*Tillandsia stricta*	Medium	Narrow	serrate	Acuminate	rosette	Simple	parallel	Alternate	Distinct yellow and green bands
9	*Tradescantia spathacea* 'Sitara'	Medium	lanceolate	Entire	acute	rosette	Simple	parallel	Alternate	Green and white strips and purple beneath
	Grass like									
10	*Chlorophytum* 'Charlotte'	Medium	broad-linear	Entire	acute	attenuate	Simple	parallel	spiral	Cream white with green edging
11	*Cyperus alternifolius*	Fine	Linear	peltate-palmate	acute	NA	Simple	parallel	whorled	Dark green
12	*Ophiopogon jaburan*	Fine	Linear	Entire	acute	rosette	Simple	parallel	emerge from soil without stem	Dark green
13	*Ophiopogon jaburan* 'Variegata'	Fine	Linear	Entire	acute	rosette	Simple	parallel	emerge from soil without stem	Milky-green, striped and edged in white
14	*Scirpus cernuus*	fine	Linear	Entire	acute	rosette	Simple	parallel	grass-like, tufted plant with numerous round	Dark green
	Upright									
15	*Aglaonema nitidum* 'Curtisii'	coarse	elliptic	Entire	Acuminate	obtuse	simple	pinnate	alternate	Bluish green with silvery feather design
16	*Aglaonema pseudobracteatum*	coarse	lanceolate	Entire	Acuminate	obtuse	simple	pinnate	alternate	Deep green variegated with light green and yellow, center largely cream white

Table 12. Qualitative leaf characters of foliage plants selected for the study (Contd.,)

S. No.	Plant species	Leaf characters								
		Texture	Shape	Margin	Tip	Base	Type	Venation	Arrangement	Pigmentation
17	*Alpinia zerumbet* 'Variegata'	Coarse	oblong	entire	Acuminate	attenuate	simple	Pinnate	Spiral	Green leaves variegated in feather design with stripes and bands of creamy yellow
18	*Dieffenbachia amoena*	Coarse	ovate	entire	Acuminate	obtuse	Simple	Pinnate	Spiral	Deep green and marked with cream white bands and blotches along veins
19	*Dracaena* 'Purple Compacta'	Medium	obovate	Entire	Acute	attenuate	Simple	Pinnate	whorled	Purple
20	*Dracaena marginata*	Medium	linear	Entire	Acute	acute	simple	parallel	whorled alternately	Shiny deep olive green prettily edged in red
21	*Dracaena sanderiana*	medium	narrow-lanceolate	Entire	acute	acute	Simple	parallel	Alternate	Deep green somewhat milky & with broad marginal bands of white
22	*Nephrolepis exaltata*	fine	lanceolate; ovate	serrate; undulate	acute(leaflet)	auriculate (leaflet)	Simple	Pinnate	most emerge from the soil, usually without a stem	Rich green
23	*Peperomia clusiifolia*	Coarse	oblanceolate	entire	acute	acute	Simple	bowed	Alternate	Metallic olive-green with broad, red-purple margin
24	*Peperomia obtusifolia* 'Sensation'	Coarse	obovate	Entire	obtuse	obtuse	Simple	bowed	Alternate	Light green variegated with milky green & from the margin inward, a broad area of creamy-white
25	*Pleomeie reflexa*	Coarse	lanceolate	Entire	acute	acute	Simple	Parallel	Opposite	Deep glossy green
26	*Sansevieria trifasciata* 'Hahnii'	Coarse	elliptic	entire	acute	attenuate	Simple	Parallel	Basal rosette	Dark green with pale green crossbanding
27	*Sansevieria trifasciata* 'Laurentii'	Coarse	Linear	undulate	acuminate	attenuate	Simple	Parallel	Rosette	Yellow bands on either side of the deep green
28	*Zamioculcas zamiifolia*	Coarse	oblanceolate	Entire	acute	acute	Simple	Pinnate	Opposite	Glossy green
	Tree like									
29	*Chrysalidocarpus lutescens*	Coarse	linear(leaflet)	pinnate	acute	attenuate	compound	Pinnate	Whorled	Glossy yellow-green
30	*Codiaeum variegatum* 'Delaware'	Coarse	obovate	Entire	acuminate	acute	Simple	Pinnate	Alternate	Greenish yellow-striped and blotched
31	*Codiaeum variegatum* 'Punctatum aureum'	Fine	linear	Entire	acute	acute	Simple	Pinnate	Alternate	Dark glossy green with freely spotted yellow
32	*Ficus benjamina*	Fine	Ovate	entire;undulate	Acuminate	acute	Simple	Pinnate	Alternate	Deep green
33	*Licuala grandis*	Coarse	rhomboidal	lobed	obtuse	obtuse	Simple	Palmate	Whorled	Bright green
34	*Polyscias guilfoylei* 'Quinquefolia'	Fine	oblong(leaflet)	lobed	emarginate	Cordate	compound	Pinnate	Alternate	Deep coppery olive green
35	*Polyscias paniculata* 'Variegata'	Fine	Obovate	serrate	obtuse	acute	compound	Pinnate	Opposite	Deep green and richly splashed with cream and greenish-white
36	*Rhapis excelsa*	Medium	Fan-shape	lobed	acute	obtuse	compound	Palmate	Alternate	Glossy green
37	*Schefflera arboricola*	Medium	Obovate	Palmatifid	Acute	Acute	Palmately compound	Pinnate	Alternate	Glossy green

Table 12. Qualitative leaf characters of foliage plants selected for the study (Contd.,)

S. No.	Plant species	Leaf characters								
		Texture	Shape	Margin	Tip	Base	Type	Venation	Arrangement	Pigmentation
	Flowering									
38	*Anthurium andreanum* 'First Red'	Coarse	Saggitate	Revolute	Acute	Sagitate	Simple	Brachidodrome pinnate	Alternate	Green
39	*Chrysothemis pulchella*	Medium	Elliptic	Crenate	Acute	Acute	Simple	Pinnate	Opposite	Shiny bright green
40	*Costus curvibracteatus*	Coarse	Elliptic (oval)	Undulate	Acuminate	Acute	Simple	Parallel	Alternate	Fresh green
41	*Iris innominata*	Coarse	Linear	Entire	Acute	Attenuate	Simple	Parallel	Most emerge from the soil, usually without a stem	Green
42	*Kalanchoe blossfeldiana*	Medium	Oblong	Crenate	Obtuse	Obtuse	Simple	Pinnate	Opposite;sub-opposite	Glossy green
43	*Spathiphyllum wallisii*	Coarse	Oblanceolate	Entire	Acute	Acute	Simple	Pinnate	Whorled	Glossy green
44	*Tacca chantrieri*	Coarse	Obovate	Entire	Acuminate	Oblique	Simple	Pinnate	Whorled	Olive-green
	Climbing & Trailing									
45	*Asparagus setaceus*	Fine	Needle	Phylloclades	Acute	Acute	Simple	Pinnate	Alternate	Rich green
46	*Philodendron* 'Ceylon Gold'	Coarse	Oblong	entire	Acuminate	Cordate	Simple	Pinnate	Alternate	yellow, gradually turning yellowish green with age
47	*Philodendron elegans*	Coarse	Elliptic(oval)	Pinnatifid	Acute	Truncate	Simple	Pinnate	Alternate	Deep green
48	*Scindapsus aureus*	Medium	Ovate	Entire	Acute	Cordate	Simple	Pinnate	Alternate	Dark green with yellow variegation
49	*Syngonium podophyllum*	Medium	Saggitate (arrow)	Lobed	Acute	Acute	Simple	Brachidodrome	Alternate	Green
50	*Syngonium wendlandii*	Coarse	Deltoid	Lobed	Acute	Acute	Simple	Pinnate	Alternate	Deep green, velvety leaves, sharply contrasting white veins

Table 13. Growing habit and incidence of pests and diseases of foliage plants in the two systems

S. No.	Plant species	Branching habit*	Bending/Drooping		Pests & Diseases	
			OV	FP	OV	FP
	Rosette					
1	*Anthurium crystallinum*	With single main stem	NR	NR	NR	NR
2	*Begonia rex*	Profusely branching	Falling down	Falling down	Stem rot	Snails, ants
3	*Calathea ornata* 'Roseo-lineata'	Clumping stems	Straight	Straight	Mealy bugs	NR
4	*Calathea zebrina*	Clumping stems	Straight	Straight	Mealy bugs	Termites
5	*Homalomena wallisii*	NR	NR	NR	Snails	Termites
6	*Philodendron wendlandii*	With single main stem	NR	NR	*Spodoptera litura*	NR
7	*Rhoeo discolor*	Side shoots	NR	NR	Fungus	NR
8	*Tillandsia stricta*	Profuse	NR	NR	NR	NR
9	*Tradescantia spathacea* 'Sitara'	Side shoots	NR	NR	Fungus	NR
	Grass like					
10	*Chlorophytum* 'Charlotte'	NR	NR	NR	Snails, Collar rot/stem rot, blight	Snails
11	*Cyperus alternifolius*	Typically multi-trunked or clumping stem	Leaves bent down like the ribs of an umbrella	Leaves droop when dried	NR	NR
12	*Ophiopogon jaburan*	NR	NR	NR	NR	NR
13	*Ophiopogon jaburan* 'Variegata'	NR	Drooping little	Drooping little	NR	NR
14	*Scirpus cernuus*	NR	NR	NR	NR	NR
	Upright					
15	*Aglaonema nitidum* 'Curtisii'	Producing suckers	Bending towards light source	NR	Stem rot	Stem rot
16	*Aglaonema pseudobracteatum*	Producing suckers	Bending towards light source	NR	NR	NR
17	*Alpinia zerumbet* 'Variegata'	Typically multi-trunked or clumping stem	NR	NR	Mealy bugs, Aphids	NR
18	*Dieffenbachia amoena*	Single stem/trunk	Bending towards light source	Overgrown plants bends downwards	Bacterial stem rot	Bacterial stem rot
19	*Dracaena* 'Purple Compacta'	Yes	NR	NR	Sooty mould	NR
20	*Dracaena marginata*	Slender trunk branching	NR	NR	Sooty mould	Sooty mould, ants
21	*Dracaena sanderiana*	NR	Bends if not staked	Bends if not staked	NR	NR

Table 13. Growing habit and incidence of pests and diseases of foliage plants in the two systems (Contd.,)

S. No.	Plant species	Branching habit*	Bending/Drooping		Pests & Diseases	
			OV	FP	OV	FP
22	*Nephrolepis exaltata*	NR	Yes	Yes	NR	NR
23	*Peperomia clusiifolia*	Yes	NR	NR	Stem rot	Snails
24	*Peperomia obtusifolia* 'Sensation'	Yes	NR	NR	NR	NR
25	*Pleomele reflexa*	NR	NR	NR	NR	NR
26	*Sansevieria trifasciata* 'Hahnii'	Producing suckers	NR	NR	NR	NR
27	*Sansevieria trifasciata* 'Laurentii'	Clustering from fleshy rhizomes	NR	NR	NR	Leaf rot
28	*Zamioculcas zamiifolia*	NR	NR	NR	NR	NR
	Tree like					
29	*Chrysalidocarpus lutescens*	NR	NR	NR	NR	NR
30	*Codiaeum variegatum* 'Delaware'	Yes	NR	NR	NR	NR
31	*Codiaeum variegatum* 'Punciatum aureum'	Yes	NR	NR	NR	NR
32	*Ficus benjamina*	Yes	NR	NR	Thrips	NR
33	*Licuala grandis*	NR	NR	NR	NR	NR
34	*Polyscias guilfoylei*	Yes	NR	NR	NR	NR
35	*Polyscias paniculata* 'Variegata'	Yes	NR	NR	Leaf spot, tip burn	Tip drying
36	*Rhapis excelsa*	Forming clumps from underground suckers	NR	NR	NR	NR
37	*Schefflera arboricola*	Yes	NR	NR	NR	NR
	Flowering					
38	*Anthurium andreanum* 'First Red'	Usually with single stem	NR	NR	*Spodoptera litura*	NR
39	*Chrysothemis pulchella*	Yes	NR	NR	Stem rot	NR
40	*Costus curvibracteatus*	Multi-trunked or clumping	NR	NR	NR	NR
41	*Iris innominata*	Multi-trunked or clumping	NR	NR	NR	NR
42	*Kalanchoe blossfeldiana*	Yes	NR	NR	Wilt	NR
43	*Spathiphyllum wallisii*	Clumping	NR	NR	NR	NR
44	*Tacca chantrieri*	Clumping	NR	NR	Leaf spot	Leaf spot

Table 13. Growing habit and incidence of pests and diseases of foliage plants in the two systems (Contd.,)

S. No.	Plant species	Branching habit*	Bending/Drooping		Pests & Diseases	
			OV	FP	OV	FP
	Climbing & Trailing					
45	*Asparagus setaceus*	Produces runners	Bends if not staked	Bends if not staked	NR	NR
46	*Philodendron* 'Ceylon Gold'	Produce adventitious roots in nodes	Bends if not staked	Bends if not staked	NA	Leaf eating caterpillars
47	*Philodendron elegans*	Produce adventitious roots in nodes	Bends if not staked	Bends if not staked	NR	NR
48	*Scindapsus aureus*	Produce adventitious roots in nodes	Bends if not staked	Bends if not staked	NR	NR
49	*Syngonium podophyllum*	Produce adventitious roots in nodes	Bends if not staked	Bends if not staked	NR	NR
50	*Syngonium wendlandii*	Produce adventitious roots in nodes	Bends if not staked	Bends if not staked	Mealy bug	NR

*Similar branching habit observed in both the greenhouses, NR-Not recorded, OV-Open ventilated greenhouse, FP-Fan and pad greenhouse

Table 14. Quality rating of foliage plants by visual scoring*

S. No.	Plant species	Growth & fullness (Texture, Shape & Pattern) (10)	Colour & Pigmentation (10)	Suitability to indoor conditions (Tolerance capacity) (10)	Pest & Diseases & other problems (10)	APTI (10)	Total (50)
	Rosette						
1	*Anthurium crystallinum*	8.4	8.5	7.1	8.8	4.9	37.66
2	*Begonia rex*	7.6	6.5	5.0	6.8	3.2	29.08
3	*Calathea ornata* 'Roseo-lineata'	8.7	7.1	5.4	7.2	4.4	32.79
4	*Calathea zebrina*	8.6	7.6	5.2	7.1	6.7	35.23
5	*Homalomena wallisii*	8.4	7.4	6.4	8.2	3.3	33.74
6	*Philodendron wendlandii*	8.2	7.0	6.8	8.7	4.2	34.91
7	*Rhoeo discolor*	7.6	7.2	5.1	6.7	2.7	29.26
8	*Tillandsia stricta*	7.4	8.3	4.6	8.6	2.6	31.47
9	*Tradescantia spathacea* 'Sitara'	7.4	8.1	5.2	6.8	2.6	30.08
	Tree like						
10	*Chrysalidocarpus lutescens*	8.8	8.5	7.9	9.0	3.9	38.14
11	*Codiaeum variegatum* 'Delaware'	8.6	8.7	8.6	7.7	2.6	36.23
12	*Codiaeum variegatum* 'Punctatum aureum'	8.8	8.9	8.5	8.4	2.8	37.43
13	*Ficus benjamina*	8.8	7.6	8.3	7.8	4.4	36.89
14	*Licuala grandis*	8.4	7.5	8.7	7.5	3.6	35.66
15	*Polyscias guilfoylei*	8.9	7.1	5.0	7.8	3.1	31.91
16	*Polyscias paniculata* 'Variegata'	8.1	8.1	5.5	7.1	2.7	31.47
17	*Rhapis excelsa*	7.9	7.6	7.7	8.3	2.5	34.01
18	*Schefflera arboricola*	8.8	8.0	8.2	8.5	2.7	36.19
	Flowering						
19	*Anthurium andreanum* 'Bonina'	9.3	9.0	9.1	8.4	8.7	44.50
20	*Chrysothemis pulchella*	7.8	7.6	6.1	7.2	3.4	32.09
21	*Costus curvibracteatus*	7.6	6.7	6.2	8.3	2.7	31.47
22	*Iris innominata*	7.7	6.8	5.6	8.0	3.3	31.43
23	*Kalanchoe blossfeldiana*	8.6	7.1	6.7	7.1	2.5	32.04
24	*Spathiphyllum wallisii*	9.0	7.6	9.0	8.8	2.4	36.79
25	*Tacca chantrieri*	8.5	7.4	6.6	5.5	3.6	31.62

*Score: 1-10, 10 being the highest and 1 being the lowest

Table 14. Quality rating of foliage plants by visual scoring* (Contd.,)

S. No.	Plant species	Growth & fullness (Texture, Shape & Pattern) (10)	Colour & Pigmentation (10)	Suitability to indoor conditions (Tolerance capacity) (10)	Pest & Diseases & other problems (10)	APTI (10)	Total (50)
	Upright						
26	*Aglaonema nitidum* 'Curtisii'	8.7	8.2	7.2	6.4	3.0	33.45
27	*Aglaonema pseudobracteatum*	8.2	8.6	7.4	7.3	2.4	33.88
28	*Alpinia zerumbet* 'Variegata'	8.9	9.0	7.0	7.5	3.2	35.56
29	*Dieffenbachia amoena*	9.0	8.9	7.9	8.3	2.7	36.81
30	*Dracaena* 'Purple Compacta'	8.1	8.8	6.8	7.6	6.1	37.37
31	*Dracaena marginata*	8.0	8.8	6.4	7.3	4.5	34.99
32	*Dracaena sanderiana*	8.4	8.7	8.0	8.5	2.9	36.49
33	*Nephrolepis exaltata*	8.8	6.4	7.2	8.8	2.6	33.81
34	*Peperomia clusiifolia*	7.1	7.9	7.5	7.3	2.6	32.36
35	*Peperomia obtusifolia* 'Sensation'	7.7	8.3	7.7	8.6	2.7	35.03
36	*Pleomele reflexa*	8.2	7.7	7.1	8.8	3.0	34.78
37	*Sansevieria trifasciata* 'Hahnii'	8.0	7.8	7.8	9.2	2.6	35.39
38	*Sansevieria trifasciata* 'Laurentii'	9.1	8.8	8.2	9.4	2.6	38.11
39	*Zamioculcas zamiifolia*	7.0	7.4	8.3	8.9	2.4	34.03
	Grass like						
40	*Chlorophytum* 'Charlotte'	7.5	8.3	7.3	4.7	2.5	30.33
41	*Cyperus alternifolius*	7.7	7.4	5.5	4.8	2.8	28.23
42	*Ophiopogon jaburan*	7.8	7.3	7.4	7.7	3.3	33.55
43	*Ophiopogon jaburan* 'Variegata'	8.1	8.6	7.5	7.9	2.7	34.76
44	*Scirpus cernuus*	8.0	7.2	7.4	8.1	3.1	33.81
	Climbing & Trailing						
45	*Asparagus setaceus*	8.7	6.8	6.7	6.4	4.0	32.61
46	*Philodendron* 'Ceylon Gold'	8.8	7.7	7.8	8.0	2.6	34.94
47	*Philodendron elegans*	8.0	7.2	7.6	8.5	3.3	34.56
48	*Scindapsus aureus*	9.0	8.6	8.7	8.6	2.9	37.77
49	*Syngonium podophyllum*	8.2	8.5	8.6	8.8	2.1	36.25
50	*Syngonium wendlandii*	6.6	7.2	7.6	5.2	2.6	29.18

*Score: 1-10, 10 being the highest and 1 being the lowest

4.1.2. FLOWER CHARACTERS

4.1.2.1 Quantitative characters

Though foliage is of more economic value in the foliage plants flowering was also taken into the consideration as it provides additional aesthetic values. Flower size, stalk length, number of flowers in case of large flowers, longevity of flowers in plants, months of flower production etc. were observed with respect to the different growing systems and presented in Table 15.

4.1.2.2. Qualitative characters

Flower characters like type, colour, appearance, fading and fragrance were observed and presented in Table 16.

4.1.3. WEATHER PARAMETERS

Maximum and minimum temperatures, relative humidity and light intensity that prevailed in the growing systems were recorded and are presented in Appendix 1.

4.1.3.1. Correlation studies

The weather parameters were correlated with different plant characters like height, spread, number of leaves and leaf area to find out the influence of weather on growth of foliage plants and the results are given in Tables 17-20.

4.1.3.1.1. Correlation between maximum temperature and plant characters

Different plant characters were significantly influenced by the maximum temperature that prevailed in the growing systems. The number of leaves of *Ficus benjamina* in tree-like plants in OV was the only character which was positively correlated. The remaining characters of all the species in both systems were negatively correlated.

4.1.3.1.2. Correlation between minimum temperature and plant characters

The minimum temperature also influenced the plant characters of both systems. The number of leaves of *Ficus benjamina* was the only character that positively correlated in both

Table 15. Quantitative flower characters of foliage plants

S. No.	Plant species	Flowering observed during		No. of flowers/year/plant		Size (cm) (across)		Stalk length (cm)		Longevity of flower (days)	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Rosette										
1	*Anthurium crystallinum*	Throughout the year	Throughout the year	5.0-7.0	4.0-5.0	9.4-24.0	7.5-14.5	34.8-76.2	30.2-63.2	30.0-60.0	50.0-60.0
2	*Begonia rex*	Throughout the year	Throughout the year	Numerous	Numerous	1.0-2.0	1.0-2.0	5.0-7.0	5.0-7.0	5.0-7.0	5.0-7.0
3	*Calathea ornata* 'Roseo-lineata'	-	-	-	-	-	-	-	-	-	-
4	*Calathea zebrina*	-	-	-	-	-	-	-	-	-	-
5	*Homalomena wallisii*	Sep.-Feb.	Aug. -Feb.	10.0-15.0	10.0-12.0	7.0-12.0	6.3-13.2	12.3-15.4	11.8-16.1	21.0-32.0	20.0-34.0
6	*Philodendron wendlandii*	-	-	-	-	-	-	-	-	-	-
7	*Rhoeo discolor*	-	Feb.	-	Numerous	-	3.8-4.1	-	Tiny	-	7.0-10.0
8	*Tillandsia stricta*	July -Sep.	-	2.0-3.0	-	5.8-6.1	-	3.0-5.0	-	7.0-8.0	-
9	*Tradescantia spathacea* 'Sitara'	-	-	-	-	-	-	-	-	-	-
	Tree like										
10	*Chrysalidocarpus lutescens*	-	-	-	-	-	-	-	-	-	-
11	*Codiaeum variegatum* 'Delaware'	Dec.	-	Single	-	small	-	15.0-24.3	-	5.0-7.0	-
12	*Codiaeum variegatum* 'Punctatum aureum'	-	-	-	-	-	-	-	-	-	-
13	*Ficus benjamina*	-	-	-	-	-	-	-	-	-	-
14	*Licuala grandis*	-	-	-	-	-	-	-	-	-	-
15	*Polyscias guilfoylei*	-	-	-	-	-	-	-	-	-	-
16	*Polyscias paniculata* 'Variegata'	-	-	-	-	-	-	-	-	-	-
17	*Rhapis excelsa*	Oct.	-	Single	-	tiny	-	15.0-21.2	-	30.0-45.0	-
18	*Schefflera arboricola*	-	-	-	-	-	-	-	-	-	-

Table 15. Quantitative flower characters of foliage plants (Contd.,)

S. No.	Plant species	Flowering observed during		No. of flowers/year/plant		Size (cm) (across)		Stalk length (cm)		Longevity of flower (days)	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
	Flowering										
19	*Anthurium andreanum* 'Bonina'	Throughout the year	Throughout the year	11.0	8.0	5.0-14.7	6.2-17.4	15.0-37.0	16.6-44.8	83.0-93.0	108.0-133.0
20	*Chrysothemis pulchella*	Jan. -Sep.	Apr.- Jan.	Cluster	Cluster	1.8-2.0	1.8-2.0	3.4-4.2	3.4-4.2	Corolla-1 or 2, calyx-10 to 14	Corolla-1 or 2, calyx-10 to 14
21	*Costus curvibracteatus*	Dec. -July	Dec.-July	Cluster	Cluster	4.4-5.4	4.3-5.2	-	-	21.0-30.0	21.0-30.0
22	*Iris innominata*	July	Mar.-Apr.	Single	-	11.3-12.5	-	8.4-10.7	-	7.0-10.0	-
23	*Kalanchoe blossfeldiana*	Dec.-June	Jan.-June	Cluster	Cluster	15.8-22.1	14.8-23.2	19.9-23.5	18.7-23.3	14.0-21.0	14.0-21.0
24	*Spathiphyllum wallisii*	Throughout the year	Throughout the year	6.0-8.0	6.0-8.0	11.8-16.7	11.0-17.1	36.2-51.2	37.3-56.2	39.0-45.0	34.0-92.0
25	*Tacca chantrieri*	Throughout the year	Throughout the year	10.0-12.0	8.0-10.0	5.2-8.6	6.4-8.9	21.5-48.6	11.8-47.5	14.0-22.0	14.0-21.0
	Upright										
26	*Aglaonema nitidum* 'Curtisii'	-	Mar.-Apr.	-	2.0-3.0	-	6.3-7.1	-	9.7-12.4	-	10.0-15.0
27	*Aglaonema pseudobracteatum*	Dec., Jan.	Dec., Jan.	2.0-3.0	2.0-3.0	8.3-9.2	6.4-7.8	9.5-10.2	9.3-10.1	5.0-7.0	7.0-10.0
28	*Alpinia zerumbet* 'Variegata'	-	-	-	-	-	-	-	-	-	-
29	*Dieffenbachia amoena*	-	-	-	-	-	-	-	-	-	-
30	*Dracaena* 'Purple Compacta'	-	-	-	-	-	-	-	-	-	-
31	*Dracaena marginata*	-	-	-	-	-	-	-	-	-	-
32	*Dracaena sanderiana*	-	-	-	-	-	-	-	-	-	-
33	*Nephrolepis exaltata*	-	-	-	-	-	-	-	-	-	-

Table 15. Quantitative flower characters of foliage plants (Contd.,)

S. No.	Plant species	Flowering observed during		No. of flowers/year/plant		Size (cm) (across)		Stalk length (cm)		Longevity of flower (days)	
		OV	FP	OV	FP	OV	FP	OV	FP	OV	FP
34	*Peperomia clusiifolia*	Throughout the year	Throughout the year	7.0-10.0	7.0-10.0	Small	-	-	-	21.0-30.0	21.0-30.0
35	*Peperomia obtusifolia* 'Sensation'	Throughout the year	Throughout the year	10.0-12.0	10.0-12.0	Small	-	-	-	21.0-30.0	21.0-30.0
36	*Pleomele reflexa*	-	-	-	-	-	-	-	-	-	-
37	*Sansevieria trifasciata* 'Hahnii'	-	-	-	-	-	-	-	-	-	-
38	*Sansevieria trifasciata* 'Laurentii'	Nov.-Jan.	Dec.-Feb.	Single	Single	Small	Small	73.6	65.7	26.0	21.0
39	*Zamioculcas zamiifolia*	-	-	-	-	-	-	-	-	-	-
	Grass like										
40	*Chlorophytum* 'Charlotte'	Throughout the year	Throughout the year	Numerous	Numerous	Small in clusters	Small in clusters	21.8-51.1	25.8-46.2	14.0-21.0	14.0-21.0
41	*Cyperus alternifolius*	Dec.-June	Dec.-June	Numerous	Numerous	2.8-3.5	2.6-3.3	2.6-3.9	2.5-3.8	30.0-45.0	30.0-45.0
42	*Ophiopogon jaburan*	-	-	-	-	-	-	-	-	-	-
43	*Ophiopogon jaburan* 'Variegata'	-	-	-	-	-	-	-	-	-	-
44	*Scirpus cernuus*	-	-	-	-	-	-	-	-	-	-
	Climbing & Trailing										
45	*Asparagus setaceus*	-	-	-	-	-	-	-	-	-	-
46	*Philodendron* 'Ceylon Gold'	Mar.-Apr.	-	-	-	12.5-15.8	-	13.6-16.4	-	21.0-28.0	-
47	*Philodendron elegans*	Nov.-March	-	2.0	-	7.5-13.2	-	12.4-14.1	-	14.0-21.0	-
48	*Scindapsus aureus*	-	-	-	-	-	-	-	-	-	-
49	*Syngonium podophyllum*	-	-	-	-	-	-	-	-	-	-
50	*Syngonium wendlandii*	-	-	-	-	-	-	-	-	-	-

Table 16. Qualitative flower characters of foliage plants

S. No	Plant species	Flower characters- Qualitative				
		Type	Colour	Appearance	Fading	Fragrance
	Rosette					
1	*Anthurium crystallinum*	Spadix	Yellowish-green spadix, green spathe, red-purple berries	Long-stalked inflorescence with slender spadix and linear spathe	-	Clove smell
2	*Begonia rex*	Cyme	White	Small, fused petals and sepals	-	-
3	*Calathea ornata* 'Roseo-lineata'	-	-	-	-	-
4	*Calathea zebrina*	-	-	-	-	-
5	*Homalomena wallisii*	Spadix	Dark purple	With semi closed spathe	-	-
6	*Philodendron wendlandii*	-	-	-	-	-
7	*Rhoeo discolor*	Cymose	White	Little flowers peeking from boatshaped bracts	-	-
8	*Tillandsia stricta*	Spike	Cream yellow	-	-	Strong
9	*Tradescantia spathacea* 'Sitara'	-	-	-	-	-
	Grass like					
10	*Chlorophytum* 'Charlotte'	Raceme	White	Long branched inflorescence and clustered	-	-
11	*Cyperus alternifolius*	Umbel	Brown	Unattractive, clustered at the apical part	-	-
12	*Ophiopogon jaburan*	-	-	-	-	-
13	*Ophiopogon jaburan* 'Variegata'	-	-	-	-	-
14	*Scirpus cernuus*	-	-	-	-	-
	Upright					
15	*Aglaonema nitidum* 'Curtisii'	Spadix	Cream white	With semi closed spathe	-	-
16	*Aglaonema pseudobracteatum*	Spadix	Greenish white spathe and cream spadix	cupped, waxy	-	-
17	*Alpinia zerumbet* 'Variegata'	-	-	-	-	-

Table 16. Qualitative flower characters of foliage plants (Contd.,)

S. No	Plant species	Flower characters- Qualitative				
		Type	Colour	Appearance	Fading	Fragrance
18	*Dieffenbachia amoena*	-	-	-	-	-
19	*Dracaena* 'Purple Compacta'	-	-	-	-	-
20	*Dracaena marginata*	-	-	-	-	-
21	*Dracaena sanderiana*	-	-	-	-	-
22	*Nephrolepis exaltata*	-	-	-	-	-
23	*Peperomia clusiifolia*	Spike	Yellow to brown	Conical	-	-
24	*Peperomia obtusifolia* 'Sensation'	Spike	Yellow to brown	Conical	-	-
25	*Pleomele reflexa*	-	-	-	-	-
26	*Sansevieria trifasciata* 'Hahnii'	-	-	-	-	-
27	*Sansevieria trifasciata* 'Laurentii'	Simple or branched raceme	Greenish white	Long flower stalk derived from apical meristem	-	-
28	*Zamioculcas zamiifolia*	-	-	-	-	-
	Tree like					
29	*Chrysalidocarpus lutescens*	-	-	-	-	-
30	*Codiaeum variegatum* 'Delaware'	Cyathium	Cream white	Male flowers arranged in long stalk	-	-
31	*Codiaeum variegatum* 'Punctatum aureum'	-	-	-	-	-
32	*Ficus benjamina*	-	-	-	-	-
33	*Licuala grandis*	-	-	-	-	-
34	*Polyscias guilfoylei*	-	-	-	-	-
35	*Polyscias paniculata* 'Variegata'	-	-	-	-	-
36	*Rhapis excelsa*	Panicle or spike	White	Small, radically symmetric	-	-
37	*Schefflera arboricola*	-	-	-	-	-

Table 16. Qualitative flower characters of foliage plants (Contd.,)

S. No	Plant species	Flower characters- Qualitative				
		Type	Colour	Appearance	Fading	Fragrance
	Flowering					
38	*Anthurium andreanum* 'Bonina'	Spadix	Spathe-coral red, Spadix-tipped yellow with white band	Waxy, cordate spathe;pendant spadix	turns green with age	-
39	*Chrysothemis pulchella*	Umbel	Corolla-bright yellow with red stripes or spots, calyx-bright orange or red	Corolla-twice the length of calyx, with arrow tube and flaring lobes	-	-
40	*Costus curvibracteatus*	Terminal head or spike	Orange	Cone like heads at the tip	-	-
41	*Iris innominata*	Zig-zagging cyme-rhipidium	Pale yellow	Fan-shaped	-	-
42	*Kalanchoe blossfeldiana*	Umbel	Bright scarlet red	Clusters	-	-
43	*Spathiphyllum wallisii*	Spadix	White	Ovate Spathe; maze like spadix	Spathe turning green with age	Slightly sweet with a spicy smell
44	*Tacca chantrieri*	Special	Black; maroon black bracts	Bat-like inflorescence; wing like bracts accompanied by long trailing filaments or "Whiskers"	-	-
	Climbing & Trailing					
45	*Asparagus setaceus*	-	-	-	-	-
46	*Philodendron* 'Ceylon Gold'	Spadix	Golden yellow	Solitary	-	-
47	*Philodendron elegans*	Spadix	Spathe-Medium green outside, maroon inside; Spadix-pale green	Solitary	-	Sweet
48	*Scindapsus aureus*	-	-	-	-	-
49	*Syngonium podophyllum*	-	-	-	-	-
50	*Syngonium wendlandii*	-	-	-	-	-

the systems. The remaining characters of all the species of different categories in both systems were negatively correlated.

4.1.3.1.3. Correlation between relative humidity and plant characters

Relative humidity is an important weather parameter which significantly influenced most of the characters of foliage plants in both the growing systems.

In OV, positive correlation was obtained in the plant characters of the following species. Number of leaves of *Anthurium crystallinum* in rosette; number of leaves and spread of *Chlorophytum* 'Charlotte' in grass-like, *Aglaonema nitidum* 'Curtisii' in upright; and leaf area of *Scindapsus aureus* in climbing and trailing type. All the other characters in rest of the species were negatively correlated.

The relative humidity prevailed in FP also significantly influenced several characters of foliage plants. Number of leaves of *Anthurium crystallinum* in rosette type, *Ficus benjamina* in tree-like plants, *Anthurium andreanum* 'Bonina' in flowering plant and leaf area of *Chlorophytum* 'Charlotte' in grass-like plants were the characters positively correlated with the relative humidity. All the other characters in the rest of the species were negatively correlated with relative humidity.

4.1.3.1.4. Correlation between light intensity and plant characters

Unlike other weather parameters, light intensity significantly influenced the characters of foliage plants positively in both the growing systems. However, negative correlation was observed in plant spread of *Aglaonema nitidum* 'Curtisii' in upright plants in OV and in FP, number of leaves of *Alpinia zerumbet* 'Variegata' and *Dieffenbachia amoena* in upright plants.

4.2. Air Pollution Tolerance Index (APTI) of foliage plants

The Air Pollution Tolerance Index was computed from four parameters, total chlorophyll content, leaf extract pH, relative water content and ascorbic acid content. The fifty foliage species selected for the study were analyzed for the above parameters for three seasons *viz.*, March-April, June-July and October-November and the APTI in these seasons were compared.

Table 17. Correlation between plant characters and maximum temperature of foliage plants grown in different systems

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
	Rosette								
1	*Anthurium crystallinum*	-0.408	0.296	-0.596*	-0.191	-0.224	-0.236	0.034	0.166
2	*Begonia rex*	-0.530	0.455	-0.618*	0.479	-0.470	0.256	0.109	0.083
3	*Calathea ornata* 'Roseo-lineata'	-0.179	0.372	-0.217	0.455	0.148	0.285	0.088	0.003
4	*Calathea zebrina*	-0.344	0.396	0.295	0.505	0.111	0.438	-0.217	-0.498
5	*Homalomena wallisii*	-0.420	0.334	-0.630*	0.382	-0.661*	0.521	-0.427	-0.206
6	*Philodendron wendlandii*	-0.406	0.338	-0.245	0.433	-0.132	0.313	0.345	0.387
7	*Rhoeo discolor*	-0.345	0.349	-0.305	0.424	-0.271	0.180	-0.021	-0.325
8	*Tillandsia stricta*	-0.577*	0.375	-0.533	0.471	-0.304	0.454	-0.411	0.488
9	*Tradescantia spathacea* 'Sitara'	-0.626*	0.359	-0.624*	0.537	-0.685*	0.318	-0.201	-0.057
	Grass like								
10	*Chlorophytum* 'Charlotte'	-0.275	0.358	-0.586*	-0.213	-0.455	-0.188	-0.079	-0.411
11	*Cyperus alternifolius*	-0.412	0.324	-0.249	0.430	-0.160	0.522	-0.190	0.109
12	*Ophiopogon jaburan*	-0.512	0.384	-0.582*	0.437	-0.287	0.318	0.078	0.272
13	*Ophiopogon jaburan* 'Variegata'	-0.423	0.239	-0.499	0.405	-0.495	0.273	0.084	0.129
14	*Scirpus cernuus*	-0.527	0.311	-0.367	0.411	-0.398	0.217	0.202	-0.148
	Upright								
15	*Aglaonema nitidum* 'Curtisii'	-0.534	0.340	-0.856*	-0.201	-0.305	0.372	-0.624*	-0.228
16	*Aglaonema pseudobracteatum*	-0.546	0.309	-0.606*	0.515	-0.424	-0.028	-0.019	-0.274
17	*Alpinia zerumbet* 'Variegata'	-0.599*	0.402	-0.791*	-0.287	-0.265	0.359	-0.035	0.106
18	*Dieffenbachia amoena*	-0.321	0.351	-0.722*	-0.701*	-0.514	-0.314	0.134	0.411
19	*Dracaena* 'Purple Compacta'	-0.544	0.329	-0.061	-0.493	-0.455	0.311	-0.329	-0.520
20	*Dracaena marginata*	-0.457	0.378	-0.724*	-0.571	-0.514	-0.212	-0.269	0.152
21	*Dracaena sanderiana*	-0.419	0.333	-0.504	0.431	-0.188	0.376	-0.316	0.281
22	*Nephrolepis exaltata*	-0.424	0.344	-0.282	0.390	-	-	-0.323	-0.146
23	*Peperomia clusiifolia*	-0.421	0.350	-0.586*	-0.282	-0.504	0.251	-0.094	0.173
24	*Peperomia obtusifolia* 'Sensation'	-0.406	0.355	-0.504	0.478	-0.342	0.272	0.054	0.454
25	*Pleomele reflexa*	-0.408	0.424	-0.450	0.412	-0.656*	-0.272	-0.036	-0.463

Table 17. Correlation between plant characters and maximum temperature of foliage plants grown in different systems (Contd.,)

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
26	*Sansevieria trifasciata* 'Hahnii'	-0.358	0.227	-0.045	0.355	-0.158	0.274	0.014	0.287
27	*Sansevieria trifasciata* 'Laurentii'	-0.611*	0.424	-0.662*	-0.453	-0.691*	0.225	-0.357	0.242
28	*Zamioculcas zamiifolia*	-0.282	0.324	-0.018	0.148	-0.227	0.078	-0.060	0.500
	Tree like								
29	*Chrysalidocarpus lutescens*	-0.349	0.407	-0.572	0.350	-0.327	0.273	-0.211	0.498
30	*Codiaeum variegatum* 'Delaware'	-0.425	0.397	-0.571	-0.483	-0.341	0.108	0.144	-0.130
31	*Codiaeum variegatum* 'Punctatum aureum'	-0.385	0.367	-0.080	0.375	-0.558	0.183	-0.297	0.481
32	*Ficus benjamina*	-0.325	0.354	0.649*	-0.255	-0.509	-0.283	0.319	-0.099
33	*Licuala grandis*	-0.516	0.424	-0.213	0.034	-0.389	-0.316	-0.219	0.238
34	*Polyscias guilfoylei* 'Quinquefolia'	-0.290	0.294	-0.091	0.425	-0.421	0.280	0.069	0.395
35	*Polyscias paniculata* 'Variegata'	-0.510	0.373	-0.744*	0.277	-0.747*	-0.247	-0.440	-0.288
36	*Rhapis excelsa*	-0.223	0.345	-0.015	0.435	-0.026	0.212	0.192	0.076
37	*Schefflera arboricola*	-0.435	0.380	-0.615*	0.396	-0.431	0.351	0.115	0.048
	Flowering								
38	*Anthurium andreanum* 'Bonina'	-0.424	0.372	-0.529	-0.168	-0.333	0.499	-0.325	0.495
39	*Chrysothemis pulchella*	-0.193	0.376	-0.715*	-0.263	-0.799*	-0.411	-0.576	-0.320
40	*Costus curvibracteatus*	-0.380	0.423	-0.161	0.305	-0.180	0.215	0.067	0.172
41	*Iris innominata*	-0.324	0.411	-0.495	0.431	-0.490	0.166	0.121	-0.067
42	*Kalanchoe blossfeldiana*	-0.311	0.482	-0.231	0.404	-0.475	0.274	-0.539	-0.073
43	*Spathiphyllum wallisii*	-0.497	0.392	-0.427	0.362	-0.642*	0.213	0.536	0.350
44	*Tacca chantrieri*	-0.502	0.380	-0.277	-0.106	-0.339	-0.238	-0.398	-0.187
	Climbing & Trailing								
45	*Asparagus setaceus*	-0.285	0.424	-0.336	0.391	-	-	0.273	0.414
46	*Philodendron* 'Ceylon Gold'	-0.370	0.373	-0.382	0.347	-	-	-0.380	-0.211
47	*Philodendron elegans*	-0.355	0.358	-0.610*	0.354	-	-	-0.230	-0.327
48	*Scindapsus aureus*	-0.521	0.335	-0.631*	0.423	-	-	-0.538	0.099
49	*Syngonium podophyllum*	-0.382	0.387	-0.636*	0.423	-	-	-0.343	0.228
50	*Syngonium wendlandii*	-0.597*	0.356	-0.743*	0.500	-	-	0.000	-0.332

*Significantly correlated at 5 % level, OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Table 18. Correlation between plant characters and minimum temperature of foliage plants grown in different systems

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
	Rosette								
1	*Anthurium crystallinum*	-0.723*	-0.385	-0.154	0.310	-0.249	-0.136	-0.476	-0.486
2	*Begonia rex*	-0.702*	-0.082	-0.788*	-0.211	-0.726*	-0.303	0.432	0.429
3	*Calathea ornata* 'Roseo-lineata'	-0.628*	-0.356	-0.414	-0.319	-0.133	-0.600*	-0.280	-0.722*
4	*Calathea zebrina*	-0.710*	-0.264	-0.057	-0.280	-0.521	-0.418	0.038	-0.155
5	*Homalomena wallisii*	-0.730*	-0.514	-0.821*	-0.393	-0.604*	-0.114	-0.310	0.082
6	*Philodendron wendlandii*	-0.708*	-0.446	-0.636*	-0.284	-0.599*	-0.443	0.040	-0.350
7	*Rhoeo discolor*	-0.718*	-0.432	-0.706*	-0.267	-0.634*	-0.536	0.171	-0.411
8	*Tillandsia stricta*	-0.760*	-0.419	-0.761*	-0.288	-0.678*	-0.399	-0.495	-0.220
9	*Tradescantia spathacea* 'Sitara'	-0.756*	-0.373	-0.856*	-0.224	-0.770*	-0.499	0.054	-0.541
	Grass like								
10	*Chlorophytum* 'Charlotte'	-0.721*	-0.325	-0.051	0.399	-0.036	-0.172	0.418	0.266
11	*Cyperus alternifolius*	-0.710*	-0.440	-0.617*	-0.197	-0.634*	-0.169	-0.375	-0.055
12	*Ophiopogon jaburan*	-0.738*	-0.379	-0.762*	-0.329	-0.712*	-0.604*	0.236	-0.448
13	*Ophiopogon jaburan* 'Variegata'	-0.707*	-0.486	-0.753*	-0.370	-0.740*	-0.455	0.108	-0.013
14	*Scirpus cernuus*	-0.810*	-0.461	-0.680*	-0.377	-0.820*	-0.524	-0.191	-0.028
	Upright								
15	*Aglaonema nitidum* 'Curtisii'	-0.801*	-0.339	-0.426	0.010	0.172	-0.176	-0.538	-0.037
16	*Aglaonema pseudobracteatum*	-0.755*	-0.393	-0.833*	-0.234	-0.582*	-0.590*	-0.044	0.031
17	*Alpinia zerumbet* 'Variegata'	-0.718*	-0.197	-0.516	0.477	-0.491	-0.172	-0.471	-0.642*
18	*Dieffenbachia amoena*	-0.730*	-0.357	-0.772*	-0.024	-0.300	-0.165	0.421	0.081
19	*Dracaena* 'Purple Compacta'	-0.784*	-0.437	0.241	-0.154	-0.700*	-0.404	-0.049	-0.180
20	*Dracaena marginata*	-0.758*	-0.387	-0.564	-0.503	-0.735*	-0.446	-0.295	-0.379
21	*Dracaena sanderiana*	-0.739*	-0.440	-0.770*	-0.336	-0.465	-0.400	-0.488	-0.499
22	*Nephrolepis exaltata*	-0.724*	-0.421	-0.729*	-0.409	-	-	-0.355	-0.670*
23	*Peperomia clusiifolia*	-0.719*	-0.028	-0.778*	0.485	-0.760*	-0.072	-0.448	-0.478
24	*Peperomia obtusifolia* 'Sensation'	-0.729*	-0.440	-0.745*	-0.248	-0.711*	-0.435	-0.488	-0.311
25	*Pleomele reflexa*	-0.742*	-0.357	-0.730*	-0.367	-0.490	0.020	0.096	-0.705*

Table 18. Correlation between plant characters and minimum temperature of foliage plants grown in different systems (Contd.,)

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
26	*Sansevieria trifasciata* 'Hahnii'	-0.691*	-0.466	-0.549	-0.481	-0.571	-0.508	-0.461	-0.647*
27	*Sansevieria trifasciata* 'Laurentii'	-0.772*	-0.310	-0.473	-0.194	-0.808*	-0.210	-0.576	0.406
28	*Zamioculcas zamiifolia*	-0.705*	-0.407	-0.556	-0.571	-0.569	-0.355	-0.573	-0.089
	Tree like								
29	*Chrysalidocarpus lutescens*	-0.747*	-0.372	-0.707*	-0.473	-0.597*	-0.555	-0.428	-0.032
30	*Codiaeum variegatum* 'Delaware'	-0.709*	-0.345	-0.737*	-0.303	-0.001	-0.517	0.037	-0.789*
31	*Codiaeum variegatum* 'Punctatum aureum'	-0.713*	-0.436	-0.555	-0.399	-0.811*	-0.588*	-0.425	-0.207
32	*Ficus benjamina*	-0.734*	-0.450	0.863*	0.694*	-0.372	-0.344	0.438	-0.317
33	*Licuala grandis*	-0.763*	-0.301	-0.546	-0.657*	-0.767*	-0.253	-0.542	-0.654*
34	*Polyscias guilfoylei* 'Quinquefolia'	-0.728*	-0.513	-0.505	-0.338	-0.651*	-0.545	-0.183	0.234
35	*Polyscias paniculata* 'Variegata'	-0.765*	-0.360	-0.341	0.051	-0.537	0.133	-0.155	-0.351
36	*Rhapis excelsa*	-0.691*	-0.451	-0.596*	-0.393	-0.451	-0.593	-0.330	-0.531
37	*Schefflera arboricola*	-0.757*	-0.449	-0.784*	-0.412	-0.759*	-0.405	-0.413	-0.638*
	Flowering								
38	*Anthurium andreanum* 'Bonina'	-0.760*	-0.267	-0.505	0.278	-0.630*	-0.259	-0.401	-0.330
39	*Chrysothemis pulchella*	-0.530	-0.355	-0.508	-0.184	-0.540	-0.576	-0.587*	0.293
40	*Costus curvibracteatus*	-0.676*	-0.280	-0.660*	-0.386	-0.304	-0.524	0.386	0.302
41	*Iris innominata*	-0.699*	-0.232	-0.782*	-0.390	-0.764*	-0.664*	0.080	-0.228
42	*Kalanchoe blossfeldiana*	-0.704*	-0.265	-0.704*	-0.386	-0.724*	-0.482	-0.623*	-0.335
43	*Spathiphyllum wallisii*	-0.730*	-0.248	-0.790*	-0.428	-0.594*	-0.657*	0.295	-0.198
44	*Tacca chantrieri*	-0.794*	-0.366	-0.613*	-0.700*	-0.652*	-0.612*	-0.150	-0.659*
	Climbing & Trailing								
45	*Asparagus setaceus*	-0.641*	-0.401	-0.693*	-0.368	-	-	0.456	-0.126
46	*Philodendron* 'Ceylon Gold'	-0.718*	-0.380	-0.723*	0.491	-	-	-0.718*	-0.680*
47	*Philodendron elegans*	-0.740*	-0.386	-0.777*	-0.090	-	-	-0.267	-0.014
48	*Scindapsus aureus*	-0.778*	-0.479	-0.786*	-0.316	-	-	-0.185	0.140
49	*Syngonium podophyllum*	-0.723*	-0.432	-0.771*	-0.285	-	-	-0.640*	-0.634*
50	*Syngonium wendlandii*	-0.772*	-0.475	-0.463	-0.308	-	-	-0.212	-0.255

*Significantly correlated at 5 % level, OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Table 19. Correlation between plant characters and relative humidity of foliage plants grown in different systems

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
	Rosette								
1	*Anthurium crystallinum*	-0.517	-0.502	0.659*	0.793*	0.045	0.491	-0.515	-0.538
2	*Begonia rex*	-0.312	-0.436	-0.261	-0.618*	-0.422	-0.259	0.432	-0.015
3	*Calathea ornata* 'Roseo-lineata'	-0.647*	-0.596*	-0.262	-0.539	-0.438	-0.697*	-0.551	-0.694*
4	*Calathea zebrina*	-0.628*	-0.491	-0.717*	-0.600*	-0.687*	-0.656*	-0.076	0.343
5	*Homalomena wallisii*	-0.495	-0.642*	-0.236	-0.625*	-0.096	-0.555	0.264	0.035
6	*Philodendron wendlandii*	-0.491	-0.526	-0.641*	-0.614*	-0.732*	-0.546	-0.513	-0.564
7	*Rhoeo discolor*	-0.579*	-0.507	-0.619*	-0.575	-0.559	-0.422	-0.277	-0.178
8	*Tillandsia stricta*	-0.129	-0.586*	-0.375	-0.666*	-0.582*	-0.615*	-0.033	-0.555
9	*Tradescantia spathacea* 'Sitara'	-0.059	-0.491	-0.202	-0.712*	-0.139	-0.590*	0.117	-0.401
	Grass like								
10	*Chlorophytum* 'Charlotte'	-0.653*	-0.486	0.818*	0.259	0.557	-0.158	0.198	0.692*
11	*Cyperus alternifolius*	-0.444	-0.459	-0.472	-0.489	-0.675*	-0.533	-0.372	-0.267
12	*Ophiopogon jaburan*	-0.401	-0.500	-0.322	-0.561	-0.629*	-0.592*	0.004	-0.768*
13	*Ophiopogon jaburan* 'Variegata'	-0.475	-0.440	-0.380	-0.576*	-0.349	-0.570	-0.410	0.203
14	*Scirpus cernuus*	-0.282	-0.510	-0.545	-0.619*	-0.472	-0.489	-0.552	-0.240
	Upright								
15	*Aglaonema nitidum* 'Curtisii'	-0.362	-0.480	0.756*	0.493	0.859*	-0.145	0.350	0.372
16	*Aglaonema pseudobracteatum*	-0.385	-0.432	-0.290	-0.593*	-0.052	-0.265	0.108	0.056
17	*Alpinia zerumbet* 'Variegata'	-0.236	-0.505	0.567	0.315	-0.426	-0.434	-0.564	-0.769*
18	*Dieffenbachia amoena*	-0.646*	-0.476	-0.077	0.454	0.443	0.156	-0.070	-0.228
19	*Dracaena* 'Purple Compacta'	-0.364	-0.527	-0.050	0.314	-0.450	-0.394	0.418	0.157
20	*Dracaena marginata*	-0.480	-0.629*	0.128	0.119	-0.323	-0.048	-0.479	-0.692*
21	*Dracaena sanderiana*	-0.522	-0.561	-0.371	-0.588*	-0.652*	-0.550	-0.386	-0.420
22	*Nephrolepis exaltata*	-0.492	-0.560	-0.625*	-0.559	-	-	-0.300	-0.278
23	*Peperomia clusiifolia*	-0.475	-0.367	-0.248	0.463	-0.360	-0.434	-0.442	-0.763*
24	*Peperomia obtusifolia* 'Sensation'	-0.484	-0.595*	-0.372	-0.537	-0.578*	-0.666*	-0.698*	-0.405
25	*Pleomele reflexa*	-0.518	-0.618*	-0.464	-0.585*	0.108	0.345	0.268	-0.327

Table 19. Correlation between plant characters and relative humidity of foliage plants grown in different systems (Contd.,)

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
26	*Sansevieria trifasciata* 'Hahnii'	-0.488	-0.429	-0.698*	-0.486	-0.647*	-0.496	-0.697*	-0.736*
27	*Sansevieria trifasciata* 'Laurentii'	-0.225	-0.506	0.208	0.253	-0.061	-0.312	-0.184	0.179
28	*Zamioculcas zamiifolia*	-0.540	-0.609*	-0.816*	-0.712*	-0.391	-0.140	-0.738*	-0.388
	Tree like								
29	*Chrysalidocarpus lutescens*	-0.535	-0.619*	-0.126	-0.700*	-0.447	-0.610*	-0.447	-0.401
30	*Codiaeum variegatum* 'Delaware'	-0.501	-0.566	-0.047	0.302	0.135	-0.379	-0.227	-0.510
31	*Codiaeum variegatum* 'Punctatum aureum'	-0.539	-0.596*	-0.663*	-0.624*	-0.360	-0.499	0.298	-0.216
32	*Ficus benjamina*	-0.612*	-0.656*	0.195	0.800*	0.023	0.110	-0.128	-0.336
33	*Licuala grandis*	-0.403	-0.533	-0.657*	-0.424	-0.532	0.209	-0.353	-0.743*
34	*Polyscias guilfoylei* 'Quinquefolia'	-0.636*	-0.600*	-0.414	-0.563	-0.422	-0.714*	-0.587*	-0.139
35	*Polyscias paniculata* 'Variegata'	-0.392	-0.507	0.646*	-0.068	0.268	0.126	0.113	-0.148
36	*Rhapis excelsa*	-0.708*	-0.634*	-0.795	-0.629*	-0.745*	-0.619*	-0.636*	-0.584*
37	*Schefflera arboricola*	-0.485	-0.653*	-0.254	-0.584*	-0.517	-0.630*	-0.781*	-0.740*
	Flowering								
38	*Anthurium andreanum* 'Bonina'	-0.513	-0.494	0.249	0.708*	-0.453	-0.414	-0.288	-0.600*
39	*Chrysothemis pulchella*	-0.551	-0.556	0.242	0.039	0.277	0.007	0.116	0.452
40	*Costus curvibracteatus*	-0.524	-0.534	-0.674*	-0.649*	-0.489	-0.492	0.257	0.119
41	*Iris innominata*	-0.559	-0.445	-0.368	-0.598*	-0.338	-0.670*	-0.318	0.184
42	*Kalanchoe blossfeldiana*	-0.587*	-0.545	-0.685*	-0.615*	-0.400	-0.460	0.070	-0.103
43	*Spathiphyllum wallisii*	-0.287	-0.482	-0.464	-0.579*	0.027	-0.596*	-0.371	-0.444
44	*Tacca chantrieri*	-0.291	-0.494	-0.603*	-0.569	-0.550	-0.393	0.219	-0.339
	Climbing & Trailing								
45	*Asparagus setaceus*	-0.581*	-0.617*	-0.528	-0.669*	-	-	-0.297	-0.563
46	*Philodendron* 'Ceylon Gold'	-0.536	-0.592*	-0.482	0.187	-	-	-0.389	-0.484
47	*Philodendron elegans*	-0.564	-0.610*	-0.239	-0.251	-	-	-0.042	0.391
48	*Scindapsus aureus*	-0.385	-0.623*	-0.248	-0.583*	-	-	0.680*	-0.009
49	*Syngonium podophyllum*	-0.381	-0.644*	-0.202	-0.536	-	-	-0.480	-0.643*
50	*Syngonium wendlandii*	-0.186	-0.622*	0.512	-0.481	-	-	-0.209	-0.226

*Significantly correlated at 5 % level, OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

Table 20. Correlation between plant characters and light intensity of foliage plants grown in different systems

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
	Rosette								
1	*Anthurium crystallinum*	0.700*	0.627*	-0.245	0.006	0.354	0.207	0.462	0.426
2	*Begonia rex*	0.537	0.665*	0.518	0.564	0.594*	0.484	-0.508	-0.432
3	*Calathea ornata* 'Roseo-lineata'	0.675*	0.561	0.246	0.655*	0.291	0.379	0.683*	0.190
4	*Calathea zebrina*	0.729*	0.653*	0.654*	0.647*	0.629*	0.556	0.211	0.113
5	*Homalomena wallisii*	0.673*	0.339	0.428	0.581*	0.470	0.579*	-0.142	-0.293
6	*Philodendron wendlandii*	0.661*	0.640*	0.746*	0.582*	0.588*	0.625*	0.433	0.283
7	*Rhoeo discolor*	0.737*	0.356	0.734*	0.619*	0.695*	0.582*	0.378	-0.119
8	*Tillandsia stricta*	0.381	0.596*	0.606*	0.550	0.691*	0.629*	0.000	0.643*
9	*Tradescantia spathacea* 'Sitara'	0.333	0.653*	0.406	0.601*	0.448	0.542	0.126	-0.040
	Grass like								
10	*Chlorophytum* 'Charlotte'	0.705*	0.661*	-0.474	-0.443	-0.189	-0.052	0.076	-0.190
11	*Cyperus alternifolius*	0.613*	0.667*	0.624*	0.551	0.755*	0.668*	0.338	0.084
12	*Ophiopogon jaburan*	0.608*	0.661*	0.553	0.663*	0.662*	0.409	0.180	0.060
13	*Ophiopogon jaburan* 'Variegata'	0.687*	0.596*	0.593*	0.642*	0.607*	0.560	0.414	0.324
14	*Scirpus cernuus*	0.477	0.605*	0.720*	0.609*	0.594*	0.556	0.323	-0.228
	Upright								
15	*Aglaonema nitidum* 'Curtisii'	0.575	0.642*	-0.464	0.358	-0.745*	0.598*	-0.270	0.041
16	*Aglaonema pseudobracteatum*	0.602*	0.644*	0.499	0.719*	0.302	0.399	-0.152	-0.394
17	*Alpinia zerumbet* 'Variegata'	0.500	0.648*	-0.260	-0.654*	0.723*	0.487	0.439	0.001
18	*Dieffenbachia amoena*	0.736*	0.663*	0.335	-0.697*	-0.244	-0.401	0.187	0.645*
19	*Dracaena* 'Purple Compacta'	0.591*	0.633*	0.238	-0.148	0.632*	0.659*	-0.016	-0.376
20	*Dracaena marginata*	0.677*	0.567	0.232	-0.294	0.538	-0.381	0.615*	-0.022
21	*Dracaena sanderiana*	0.696*	0.609*	0.592*	0.653*	0.720*	0.658*	0.541	0.485
22	*Nephrolepis exaltata*	0.711*	0.610*	0.736*	0.654*	-	-	0.605*	0.297
23	*Peperomia clusiifolia*	0.686*	0.634*	0.476	-0.551	0.593*	0.073	0.657*	-0.044
24	*Peperomia obtusifolia* 'Sensation'	0.652*	0.592*	0.600*	0.700*	0.739*	0.440	0.624*	0.690*
25	*Pleomele reflexa*	0.693*	0.599*	0.687*	0.646*	0.348	-0.090	-0.432	-0.220

Table 20. Correlation between plant characters and light intensity of foliage plants grown in different systems (Contd.,)

S. No.	Plant species	Plant height		No. of leaves		Plant spread		Leaf area	
		OV	FP	OV	FP	OV	FP	OV	FP
26	*Sansevieria trifasciata* 'Hahnii'	0.619*	0.610*	0.640*	0.636*	0.728*	0.579*	0.646*	0.354
27	*Sansevieria trifasciata* 'Laurentii'	0.471	0.679*	0.171	-0.221	0.362	0.225	0.424	0.594*
28	*Zamioculcas zamiifolia*	0.732*	0.558	0.766*	0.326	0.534	0.185	0.655*	0.669*
	Tree like								
29	*Chrysalidocarpus lutescens*	0.655*	0.580*	0.325	0.438	0.745*	0.500	0.596*	0.644*
30	*Codiaeum variegatum* 'Delaware'	0.659*	0.630*	0.222	0.021	0.116	0.509	0.567	0.057
31	*Codiaeum variegatum* 'Punctatum aureum'	0.739*	0.596*	0.714*	0.567	0.578*	0.498	0.425	0.799*
32	*Ficus benjamina*	0.720*	0.546	-0.423	-0.132	0.291	0.062	0.085	-0.322
33	*Licuala grandis*	0.626*	0.633*	0.790*	0.329	0.667*	0.052	0.626*	0.112
34	*Polyscias guilfoylei* 'Quinquefolia'	0.721*	0.533	0.436	0.655*	0.682*	0.454	0.777*	0.713*
35	*Polyscias paniculata* 'Variegata'	0.607*	0.664*	-0.314	0.564	0.118	-0.109	-0.183	0.082
36	*Rhapis excelsa*	0.778*	0.550	0.769*	0.594*	0.705*	0.453	0.391	0.223
37	*Schefflera arboricola*	0.664*	0.552	0.513	0.634*	0.685*	0.560	0.556	-0.091
	Flowering								
38	*Anthurium andreanum* 'Bonina'	0.673*	0.659*	0.022	-0.016	0.645*	0.806*	0.628*	0.643*
39	*Chrysothemis pulchella*	0.610*	0.627*	0.048	0.004	0.049	-0.239	0.255	-0.420
40	*Costus curvibracteatus*	0.733*	0.634*	0.578*	0.412	0.697*	0.305	-0.180	0.393
41	*Iris innominata*	0.686*	0.658*	0.535	0.621*	0.516	0.332	0.366	0.138
42	*Kalanchoe blossfeldiana*	0.739*	0.637*	0.754*	0.612*	0.608*	0.548	0.211	-0.039
43	*Spathiphyllum wallisii*	0.519	0.660*	0.618*	0.600*	0.254	0.400	0.568	0.508
44	*Tacca chantrieri*	0.517	0.679*	0.744*	-0.434	0.731*	-0.566	0.055	-0.114
	Climbing & Trailing								
45	*Asparagus setaceus*	0.739*	0.632*	0.690*	0.516	-	-	0.459	-0.031
46	*Philodendron* 'Ceylon Gold'	0.698*	0.609*	0.581*	0.683*	-	-	0.556	-0.277
47	*Philodendron elegans*	0.714*	0.577*	0.458	0.690*	-	-	-0.137	-0.275
48	*Scindapsus aureus*	0.611*	0.559	0.519	0.643*	-	-	-0.405	0.440
49	*Syngonium podophyllum*	0.589*	0.583*	0.483	0.640*	-	-	0.511	0.342
50	*Syngonium wendlandii*	0.463	0.576*	-0.170	0.750*	-	-	0.313	-0.284

*Significantly correlated at 5 % level, OV- Open ventilated greenhouse, FP- Fan and pad greenhouse

4.2.1. Total chlorophyll content

Total chlorophyll content is an important parameter to determine the air pollution tolerance index of plants. The chlorophyll content was analyzed and the values for different seasons are presented in Table 21.

The total chlorophyll content of the foliage plant species differed significantly in all the seasons. During March-April, *Asparagus setaceus* recorded the maximum chlorophyll content (3.402 mg /g) and it was closely followed by *Aglaonema nitidum* 'Curtisii' and *Dracaena marginata* with contents of 2.768 and 2.848 mg/g respectively and they were on par. The lowest content was recorded in *Scindapsus aureus* (0.063 mg/g) which is on par with *Peperomia clusiifolia* (0.112 mg/g), *Begonia rex* (0.126 mg/g), *Aglaonema pseudobracteatum* (0.147 mg/g) and *Tradescantia spathacea* 'Sitara' (0.150 mg/g).

In June-July, *Scirpus cernuus*, *Syngonium wendlandii* and *Dracaena marginata* recorded the maximum total chlorophyll content of 3.149, 3.093 and 3.085mg/g respectively and they were on par with each other. *Dracaena* 'Purple Compacta' (2.982 mg/g) was on par with *Syngonium wendlandii* and *Dracaena marginata*. The lowest content was in *Peperomia clusiifolia* (0.108 mg/g).

In October-November, the maximum value was observed in *Dracaena marginata* (3.848 mg/g) as in March-April. The lowest total chlorophyll content was observed in *Peperomia clusiifolia* (0.126 mg/g) and *Tradescantia spathacea* 'Sitara' (0.190 mg/g) which were on par with each other.

4.2.2. Leaf extract pH

As the plants depend on pH level to carry out their various physiological and biochemical functions, determining leaf extract pH also plays a vital role in evaluating the air pollution tolerance of foliage plants. So they were analyzed for their leaf extract pH for three seasons and data are presented in Table 21.

During March-April, the leaf extract pH of foliage plants differed significantly with each other. Among the species, *Ficus benjamina* stood ahead of other species with pH of 8.53 and it was closely followed by *Chysothemis pulchella* and *Spathiphyllum wallisii* with pH of 7.34 and 7.02 respectively. The lowest pH values of 3.99 and 4.26 respectively were obtained from *Anthurium crystallinum* and *Costus curvibacteatus* which were on par.

In June-July also, the foliage plants showed the same pattern of pH range as that of March-April. The highest pH values 6.67, 6.56, 6.54, 6.55 and 6.92 were obtained from *Calathea zebrina*, *Cyperus alternifolius*, *Licuala grandis*, *Polyscias paniculata* 'Variegata' and *Scindapsus aureus* respectively and they were at par. The lowest pH values were in *Anthurium crystallinum* (3.74), *Costus curvibracteatus* ((3.92), *Begonia rex* (4.16) and *Iris innominata* (4.18) and they were on par with each other.

As like March-April, during October-November *Ficus benjamina* again topped the list with the highest pH (8.00). All the other species recorded only below neutral pH. The lowest value of 3.53, 3.88 and 3.93 were observed in *Sansevieria trifasciata* 'Laurentii', *Anthurium crystallinum* and *Costus curvibracteatus* respectively and they were on par with each other.

4.2.3. Relative Water Content (RWC)

Relative water content represents turgidity which is the most important factor to keep the plants live. RWC determines the ability of plants to resist air pollutants. The RWC of the plant species in three different seasons are presented in Table 21.

The values for RWC showed significant difference with respect to species. The maximum value recorded during March-April was 98.14 per cent in *Sansevieria trifasciata* 'Laurentii' and this was on par with other 19 species. The minimum RWC was observed in *Tillandsia stricta* (70.07 %) and it was on par with *Ophiopogon jaburan* (77.27 %), *Ophiopogon jaburan* 'Variegata' (76.98 %) and *Syngonium podophyllum* (75.29 %).

During June-July, the highest RWC recorded was 99.48 per cent in *Sansevieria trifasciata* 'Hahnii' and it was on par with other thirteen species like *Anthurium andreanum* 'Bonina' (93.02 %), *Anthurium crystallinum* (93.66 %), *Begonia rex* (95.15 %) etc. The lowest RWC was 69.79 per cent in *Calathea ornata* 'Roseo-lineata' which was on par with *Cyperus alternifolius*, *Ophiopogon jaburan* 'Variegata' and *Aglaonema nitidum* 'Curtisii'.

Peperomia obtusifolia 'Sensation' had the highest RWC of 100.25 per cent during October-November and the value was on par with other twenty species like *Anthurium andreanum* 'Bonina' (94.22 %), *Anthurium crystallinum* (96.52 %), *Asparagus setaceus* (93.48 %), *Calathea ornata* 'Roseo-lineata' (94.62 %) etc.

4.2.4. Ascorbic acid content

Ascorbic acid is the main deciding factor of the tolerance of plants to air pollutants rather than any other. As far the foliage plants were concerned, they widely differed in their content ranging from a minimum of less than 1 mg/g to a maximum of more than 40 mg/g. The content was differed accordingly to the season also. The ascorbic acid content of different foliage plants with regard to different seasons is presented in Table 21.

Ascorbic acid content of foliage plants recorded during March-April ranged from the highest value of 34.9 mg/g in *Anthurium andreanum* 'Bonina' to the lowest value of 0.70 mg/g in and *Kalanchoe blossfeldiana.*

As in March-April, in June-July also the species showed considerable variations in their ascorbic acid content. The highest value (41.60 mg/g) was obtained from *Anthurium crystallinum* which was closely followed by *Anthurium andreanum* 'Bonina' (27.7 mg/g) and *Calathea zebrina* (28.4 mg/g) and they were on par with each other. The least value (0.35 mg/g) was in *Syngonium podophyllum* which was on par with *Kalanchoe blossfeldiana* (0.65 mg/g), *Peperomia clusiifolia* (1.10 mg/g), *Sansevieria trifasciata* 'Hahnii' (1.00 mg/g) and *Tradescantia spathacea* 'Sitara' (0.80 mg/g).

During October-November, *Anthurium andreanum* 'Bonina' recorded 46.70 mg/g of ascorbic acid content which was the highest value recorded among the foliage plants under study irrespective of the seasons. The lowest value (0.45 mg/g) was in *Syngonium podophyllum* and it was on par with *Chlorophytum* 'Charlotte' (0.50 mg/g), *Kalanchoe blossfeldiana* (0.68 mg/g), *Sansevieria trifasciata* 'Hahnii' (0.65 mg/g), *Sansevieria trifasciata* 'Laurentii' (1.00 mg/g) and *Tradescantia spathacea* 'Sitara' (0.80 mg/g).

4.2.5. Air Pollution Tolerance Index (APTI)

The Air Pollution Tolerance Index was computed from the above parameters. The susceptibility level of plants to air pollution was assessed and the results are presented in Table 21.

The species were significantly different in their pollution tolerance indices. During March-April, the highest and lowest APTI values computed were 32.13 and 9.18 in *Anthurium andreanum* 'Bonina' and *Aglaonema pseudobracteatum* respectively. The next highest APTI value computed was 28.64 in *Calathea zebrina* and 25.27 in *Dracaena* 'Purple Compacta'. Relatively high APTI values were computed in *Ficus benjamina* (22.11) and *Asparagus setaceus* (20.63) and they were at par. The species on par with the lowest APTI values were *Chlorophytum* 'Charlotte' (9.91), *Kalanchoe blossfeldiana* (10.16), *Ophiopogon jaburan* 'Variegata' (10.02), *Peperomia clusiifolia* (9.62), *Spathiphyllum wallisii* (9.85), *Syngonium podophyllum* (8.55), *Syngonium wendlandii* (10.02), *Tillandsia stricta* (9.83) and *Zamioculcas zamiofolia* (9.50). In rest of the species, the APTI ranged from slightly above 10 to not more than 20.

During June-July, the APTI values calculated ranged from the maximum of 30.76 in *Calathea zebrina* to the minimum of 9.84 in *Aglaonema pseudobracteatum* and it showed that the species were significantly different during rainy season also. *Anthurium andreanum* 'Bonina' with the highest value during March-April scored 29.72 and it is on par with that of *Calathea zebrina* in June-July. It was closely followed by *Anthurium crystallinum* (28.72). The next highest level of APTI was in *Dracaena* 'Purple Compacta' (26.72) and *Philodendron wendlandii* (20.56). The species having the lowest APTI value were *Cyperus alternifolius* (9.67), *Philodendron* 'Ceylon Gold' (10.00), *Polyscias paniculata* (9.96), *Rhapis excelsa* (9.23), *Spathiphyllum wallisii* (9.11), *Syngonium podophyllum* (8.41), *Syngonium wendlandii* (9.67) and *Zamioculcas zamiofolia* (9.95). Rest of the species had APTI in the range of 10-20.

In October-November, *Anthurium andreanum* 'Bonina' showed APTI value of 42.60 which is the highest among all the species under the study irrespective of the seasons. This was closely followed by *Calathea zebrina* and *Dacaena* 'Purple Compacta' with APTI values of 21.30 and 20.30 respectively and they were on par with each other. Apart from these species, none had scored more than 20. The lowest APTI value recorded was 8.81 in *Syngonium podophyllum* and it was at par with *Aglaonema pseudobracteatum* (9.50), *Chlorophytum* 'Charlotte' (9.29), *Codiaeum variegatum* 'Punctatum aureum' (10.20), *Costus curvibacteatus* (10.40), *Kalanchoe blossfeldiana* (10.20), *Nephrolepis exaltata* (10.00), *Rhapis excelsa* (9.98), *Rhoeo discolor* (10.00), *Sansevieria trifasciata* 'Laurentii' (10.30), *Spathiphyllum wallisii* (9.69), *Syngonium podophyllum* (8.81), *Tradescantia spathacea* 'Sitara' (10.30) and *Zamioculcas zamiofolia* (9.72).

4.2.6. Susceptibility levels

The susceptibility of the foliage plants to air pollution was determined based on the APTI values. The species which scored APTI values more than 18 were categorized as tolerant, 15-18 as medium tolerant, 11-14 as intermediately tolerant and species that scored below or equal to 10 were categorized as susceptible to air pollution (Singh *et al.*, 1991). The foliage plants varied in their susceptibility levels. In some the susceptibility changed with the seasons but some remained constant irrespective of the seasons. Based on their susceptibility levels in different seasons, the plants under the study were categorized into tolerant, medium tolerant, intermediately tolerant and susceptible (Table 22).

Table 21. Air Pollution Tolerance Index (APTI) of foliage plants in different seasons

S.No	Plant Species	Total Chlorophyll (mg/g)			Leaf pH			Relative Water Content (%)			Ascorbic acid content (mg/g)			Air Pollution Tolerance Index		
		Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.
1	*Aglaonema nitidum* 'Curtisii'	2.768	2.140	1.503	6.09	5.96	6.03	87.74	75.00	81.37	4.85	4.10	4.48	13.08	10.83	11.50
2	*Aglaonema pseudobracteatum*	0.147	0.506	0.404	6.24	5.90	6.36	82.61	87.33	81.48	1.45	1.73	2.00	9.18	9.84	9.50
3	*Alpinia zerumbet* 'Variegata'	0.508	0.689	1.212	6.26	6.13	6.19	90.50	92.24	92.18	4.50	4.15	6.05	12.10	12.06	13.70
4	*Anthurium andreanum* 'Bonina'	0.374	0.949	0.508	6.17	6.41	6.59	92.53	93.02	94.22	34.90	27.70	46.70	32.13	29.72	42.60
5	*Anthurium crystallinum*	0.618	0.952	0.749	3.99	3.74	3.88	94.52	93.66	96.52	10.85	41.60	11.30	14.46	28.92	14.90
6	*Asparagus setaceus*	3.402	1.604	1.447	6.15	6.31	6.33	84.31	78.67	93.48	12.75	3.70	9.40	20.63	10.80	16.70
7	*Begonia rex*	0.126	0.614	0.962	4.76	4.16	4.59	92.00	95.15	88.06	4.65	5.55	10.30	11.48	12.17	14.50
8	*Calathea ornata* 'Roseo-lineata'	0.516	2.311	1.387	5.05	6.18	6.09	90.00	69.79	94.62	12.35	12.35	13.10	15.89	17.48	19.30
9	*Calathea zebrina*	0.381	1.008	0.475	6.28	6.67	6.73	88.88	89.22	85.32	29.60	28.40	17.70	28.64	30.76	21.30
10	*Chlorophytum* 'Charlotte'	0.556	1.535	0.434	5.44	6.29	6.20	93.71	93.32	89.56	0.90	2.35	0.50	9.912	11.17	9.29
11	*Chrysalidocarpus lutescens*	1.71	1.119	1.785	4.92	5.19	5.55	88.88	88.06	88.57	11.30	10.85	8.60	16.39	15.66	15.20
12	*Chrysothemis pulchella*	2.379	1.703	2.04	7.34	6.09	6.72	94.6	94.27	94.92	4.70	4.60	4.65	14.04	13.02	13.60
13	*Codiaeum variegatum* 'Delaware'	0.422	0.458	0.44	6.21	6.21	6.21	89.03	86.75	87.89	2.47	2.73	2.60	10.54	10.50	10.50
14	*Codiaeum variegatum* 'Punctatum aureum'	0.597	0.419	0.949	6.56	6.24	6.17	81.82	83.33	84.38	6.30	4.10	2.45	12.70	11.07	10.20
15	*Costus curvibracteatus*	0.249	0.324	0.445	4.26	3.92	3.93	96.08	94.03	98.55	2.10	3.85	1.20	10.56	11.04	10.40
16	*Cyperus alternifolius*	1.576	1.947	0.939	6.36	6.56	6.60	78.82	73.75	72.50	5.70	2.70	6.15	12.41	9.67	11.90

Table 21. Air Pollution Tolerance Index (APTI) of foliage plants in different seasons (Contd.,)

S.No	Plant Species	Total Chlorophyll (mg/g)			Leaf pH			Relative Water Content (%)			Ascorbic acid content (mg/g)			Air Pollution Tolerance Index		
		Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.
17	*Dieffenbachia amoena*	0.287	0.573	0.596	6.16	5.85	6.21	89.45	89.42	94.51	2.45	2.75	2.75	10.53	10.71	11.30
18	*Dracaena marginata*	2.848	3.085	3.848	5.63	5.80	6.26	88.32	84.29	87.39	9.85	11.00	9.65	17.20	18.22	18.50
19	*Dracaena* 'Purple Compacta'	1.129	2.982	2.695	6.37	6.27	6.25	92.00	92.08	95.88	21.40	18.9	12.65	25.27	26.72	20.90
20	*Dracaena sanderiana*	0.623	1.646	0.929	5.73	5 93	6.08	85.82	90.08	89.83	3.10	3.30	5.10	10.55	11.51	12.60
21	*Ficus benjamina*	0.368	2.055	1.070	8.53	5.89	8.00	89.19	85.86	86.54	14.80	8.65	7.05	22.11	15.47	15.10
22	*Homalomena wallisii*	0.306	0.687	0.660	4.72	4.33	4.28	91.03	87.57	92.36	6.80	5.90	13.25	12.53	11.72	15.80
23	*Iris innominata*	0.203	1.040	0.683	5.16	4.18	6.34	95.71	98.08	93.10	6.80	8.50	4.60	13.22	14.25	12.50
24	*Kalanchoe blossfeldiana*	0.370	0.304	0.442	5.95	5.56	5.76	97.17	97.67	97.42	0.70	0.65	0.68	10.16	10.15	10.20
25	*Licuala grandis*	1.386	1.431	1.248	5.10	6.54	6.50	88.14	84.13	83.05	9.50	8.85	5.15	14.99	15.48	12.30
26	*Nephrolepis exaltata*	0.696	0.902	0.927	5.89	6.17	6.25	94.44	88.62	87.37	2.35	2.10	1.80	10.99	10.35	10.00
27	*Ophiopogon jaburan*	0.472	1.479	0.845	6.18	6.27	6.32	77.27	82.86	81.11	8.05	8.20	5.95	13.09	14.65	12.40
28	*Ophiopogon jaburan* 'Variegata'	0.932	1.310	1.230	6.00	5.85	6.22	76.98	74.00	75.22	3.35	5.50	4.15	10.02	11.34	10.60
29	*Peperomia clusiifolia*	0.112	0.108	0.126	6.15	4.60	5.97	90.94	98.42	99.44	0.85	1.10	1.20	9.627	10.36	10.70
30	*Peperomia obtusifolia* 'Sensation'	0.168	0.331	0.363	6.12	5.06	5.65	95.40	99.40	100.25	2.10	1.75	1.65	10.86	10.88	11.00
31	*Philodendron* 'Ceylon Gold'	0.155	0.516	0.319	6.61	6.39	6.31	92.66	90.70	91.60	1.45	1.35	3.30	10.25	10.00	11.40
32	*Philodendron elegans*	1.406	1.391	0.539	4.77	6.10	6.15	81.18	85.59	86.15	6.70	7.30	6.25	12.26	14.04	12.80
33	*Philodendron wendlandii*	0.586	1.317	1.559	6.74	6.09	6.07	89.04	88.41	84.88	11.30	15.80	5.60	17.20	20.56	12.80

Table 21. Air Pollution Tolerance Index (APTI) of foliage plants in different seasons (Contd.,)

S. No.	Plant Species	Total Chlorophyll (mg/g)			Leaf pH			Relative Water Content (%)			Ascorbic acid content (mg/g)			Air Pollution Tolerance Index		
		Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.	Mar.-Apr.	June-July	Oct.-Nov.
34	*Pleomele reflexa*	0.771	1.801	1.702	6.41	6.34	6.41	85.82	90.08	89.83	2.90	3.90	4.85	10.67	12.19	12.90
35	*Polyscias guilfoylei*	1.003	1.505	0.982	6.31	6.41	6.45	87.60	86.40	86.43	5.05	3.70	6.30	12.46	11.57	13.30
36	*Polyscias paniculata*	0.643	1.399	2.255	6.49	6.55	6.47	88.43	84.47	88.70	2.80	1.90	2.70	10.84	9.96	11.20
37	*Rhapis excelsa*	0.820	0.787	0.853	6.11	6.11	6.11	83.56	83.08	83.32	3.70	1.34	2.36	10.92	9.23	9.98
38	*Rhoeo discolor*	0.242	0.310	0.348	6.66	5.80	4.42	90.65	93.96	94.18	2.90	2.45	1.25	11.07	10.90	10.00
39	*Sansevieria trifasciata* 'Hahnii'	0.263	0.451	0.440	4.73	4.58	5.52	98.07	99.48	99.70	0.80	1.00	0.65	10.21	10.45	10.40
40	*Sansevieria trifasciata* 'Laurentii'	0.294	0.223	0.329	5.14	6.14	3.53	98.14	98.11	99.26	1.10	1.20	1.00	10.41	10.58	10.30
41	*Schefflera arboricola*	1.533	0.574	0.979	5.74	5.81	5.98	84.78	81.5	94.12	2.55	3.80	2.70	10.34	10.58	11.30
42	*Scindapsis aureus*	0.063	0.477	0.742	6.32	6.92	5.84	93.99	93.62	95.88	2.65	2.25	4.10	11.09	11.03	12.30
43	*Scirpus cernuus*	0.751	3.149	2.323	5.86	6.23	6.37	91.38	94.59	88.64	5.25	4.70	2.25	12.61	13.87	10.80
44	*Spathiphyllum wallisii*	1.014	1.219	2.372	7.02	6.34	6.20	90.48	79.38	77.62	1.00	1.55	2.25	9.853	9.11	9.69
45	*Syngonium podophyllum*	2.182	1.049	1.561	4.63	6.22	6.50	75.29	81.61	84.44	1.50	0.35	0.45	8.55	8.41	8.81
46	*Syngonium wendlandii*	1.659	3.093	2.204	5.27	5.84	6.30	89.47	78.82	82.98	1.55	2.00	3.55	10.02	9.67	11.30
47	*Tacca chantrieri*	0.354	1.156	0.869	5.90	5.83	5.02	89.12	85.63	90.70	11.65	7.20	7.70	16.21	13.60	13.60
48	*Tillandsia stricta*	1.006	0.712	0.447	6.05	5.39	6.76	70.07	84.21	84.03	4.00	3.25	3.10	9.83	10.41	10.60
49	*Tradescantia spathacea* 'Sitara'	0.150	0.230	0.190	5.72	6.32	6.02	97.89	98.66	98.26	0.80	0.80	0.80	10.26	10.39	10.30
50	*Zamioculcas zamiifolia*	0.357	0.654	0.943	6.34	6.39	5.71	88.97	87.94	86.86	0.90	1.65	1.55	9.50	9.95	9.72
	CD (0.05)	0.09	0.11	0.10	0.48	0.47	0.48	7.21	7.16	7.26	0.75	0.81	0.73	1.61	1.66	1.61

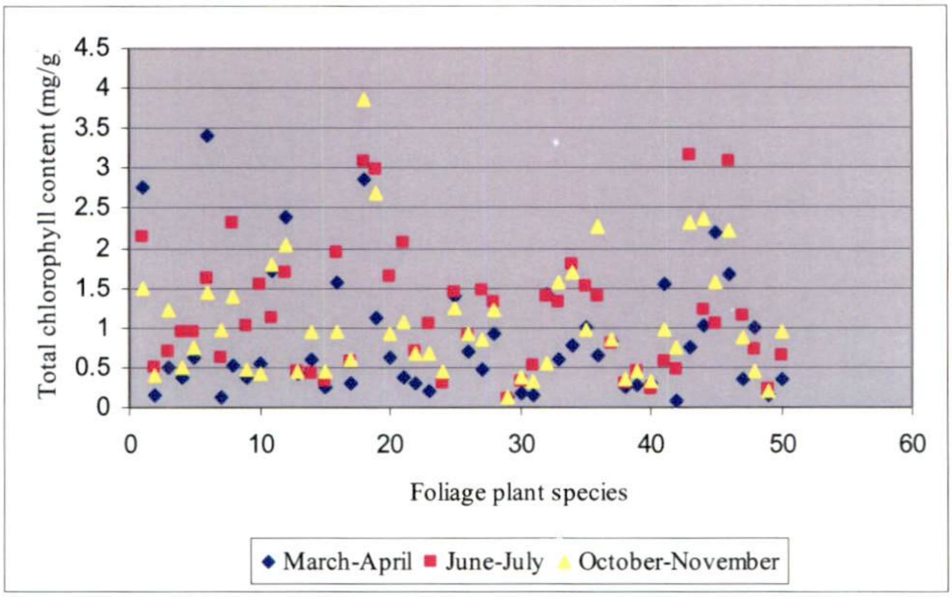


Fig 18. Total chlorophyll content of foliage plants in different seasons

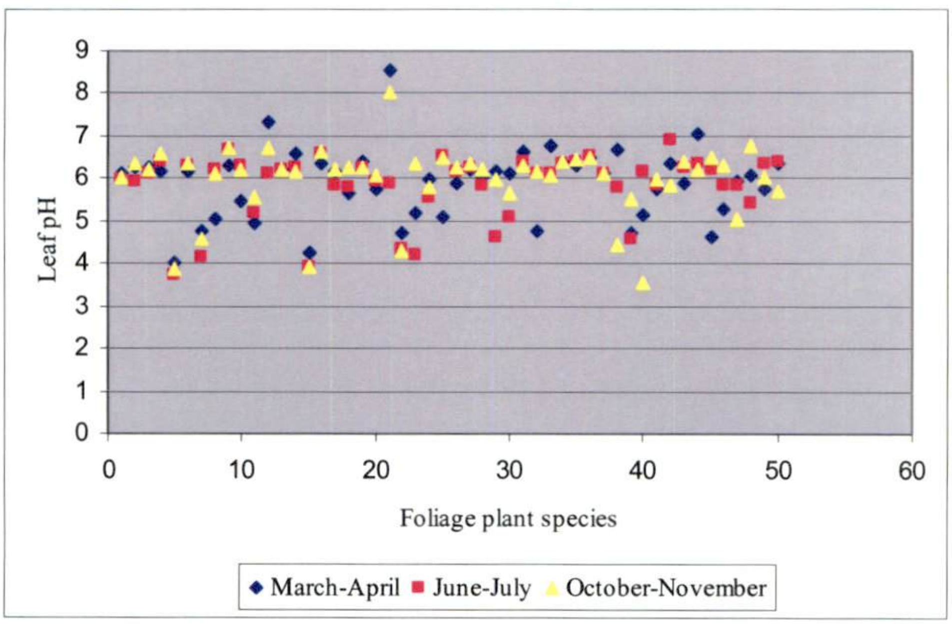


Fig 19. Leaf extract pH of foliage plants in different seasons

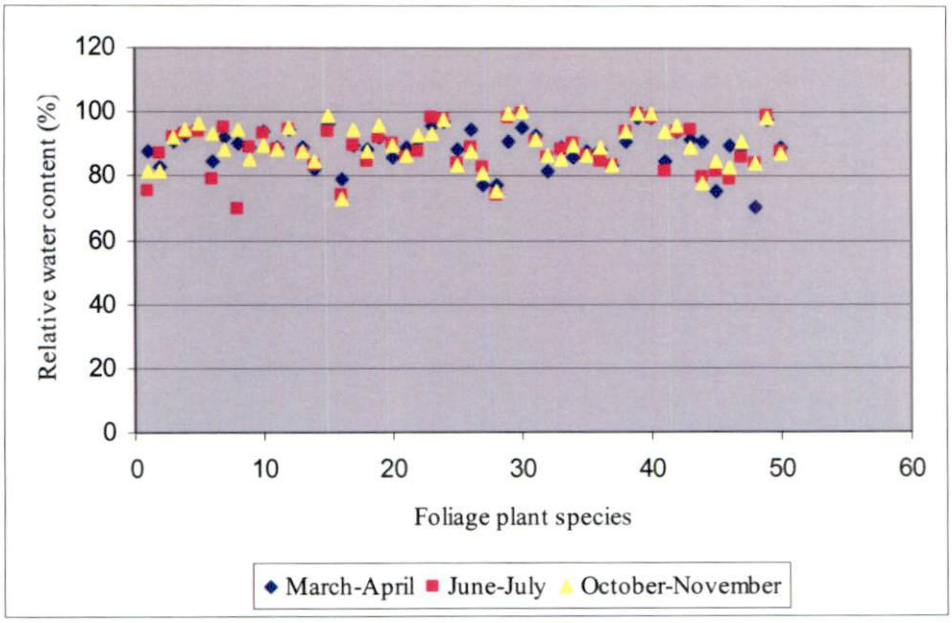


Fig 20. Relative water content of foliage plants in different seasons

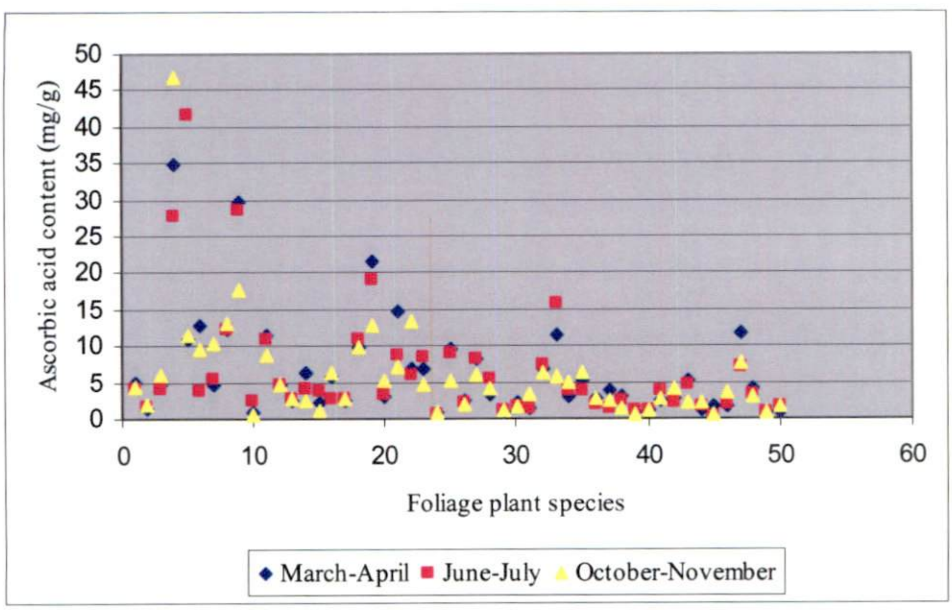


Fig 21. Ascorbic acid content of foliage plants in different seasons

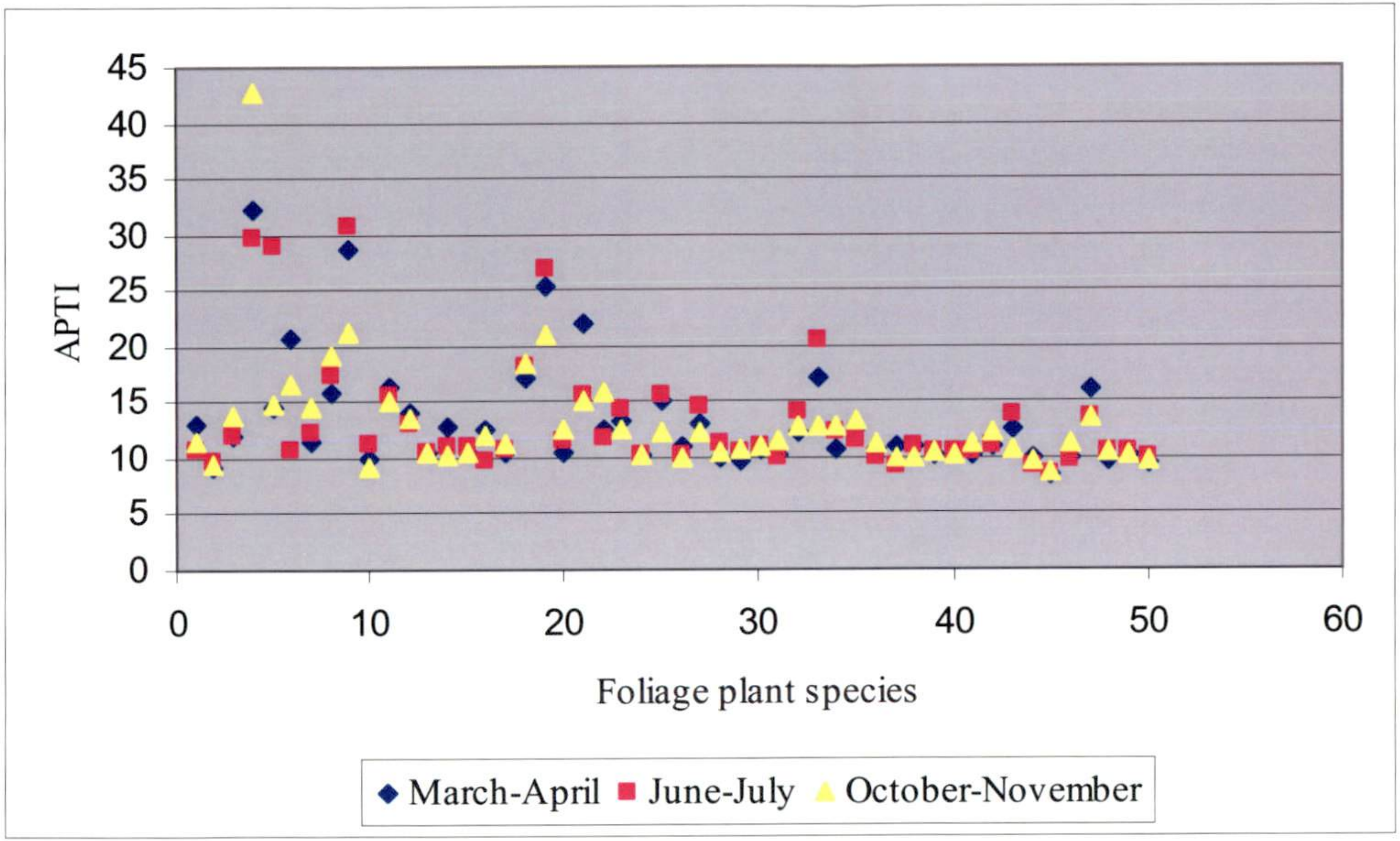


Fig 22. Air Pollution Tolerance Index (APTI) of foliage plants in different seasons

Table 22. Classification of foliage plants based on air pollution tolerance

Susceptibility levels	Seasons		
	March-April	**June-July**	**October-November**
Tolerant (APTI value>18)	*Anthurium andreanum* 'Bonina'	*Anthurium andreanum* 'Bonina'	*Anthurium andreanum* 'Bonina'
	Asparagus setaceus	*Anthurium crystallinum*	*Calathea ornata* 'Roseo-lineata'
	Calathea zebrina	*Calathea zebrina*	*Calathea zebrina*
	Dracaena 'Purple Compacta'	*Dracaena marginata*	*Dracaena marginata*
	Ficus benjamina	*Dracaena* 'Purple Compacta'	*Dracaena* 'Purple Compacta'
		Philodendron wendlandii	
Medium tolerant (15 to 18)	*Anthurium crystallinum*	*Calathea ornata* 'Roseo-lineata'	*Anthurium crystallinum*
	Calathea ornata 'Roseo-lineata'	*Chrysalidocarpus lutescens*	*Asparagus setaceus*
	Chrysalidocarpus lutescens	*Ficus benjamina*	*Begonia rex*
	Dracaena marginata	*Licuala grandis*	*Chrysalidocarpus lutescens*
	Licuala grandis	*Ophiopogon jaburan*	*Ficus benjamina*
	Philodendron wendlandii		*Homalomena wallisii*
	Tacca chantrieri		
Intermediately tolerant (11 to 14)	*Aglaonema nitidum* 'Curtisii'	*Aglaonema nitidum* 'Curtisii'	*Aglaonema nitidum* 'Curtisii'
	Alpinia zerumbet 'Variegata'	*Alpinia zerumbet* 'Variegata'	*Alpinia zerumbet* 'Variegata'
	Begonia rex	*Asparagus setaceus*	*Chrysothemis pulchella*
	Chrysothemis pulchella	*Begonia rex*	*Codiaeum variegatum* 'Delaware'
	Codiaeum variegatum 'Delaware'	*Chlorophytum* 'Charlotte'	*Cyperus alternifolius*
	Codiaeum variegatum 'Punctatum aureum'	*Chrysothemis pulchella*	*Dieffenbachia amoena*
	Costus curvibracteatus	*Codiaeum variegatum* 'Delaware'	*Dracaena sanderiana*
	Cyperus alternifolius	*Codiaeum variegatum* 'Punctatu aureum'	*Iris innominata*
	Dieffenbachia amoena	*Costus curvibracteatus*	*Licuala grandis*
	Dracaena sanderiana	*Dieffenbachia amoena*	*Ophiopogon jaburan*
	Homalomena wallisii	*Dracaena sanderiana*	*Ophiopogon jaburan* 'Variegata'
	Iris innominata	*Homalomena wallisii*	*Peperomia clusiifolia*
	Nephrolepis exaltata	*Iris innominata*	*Peperomia obtusifolia* 'Sensation'
	Ophiopogon jaburan	*Ophiopogon jaburan* 'Variegata'	*Philodendron* 'Ceylon Gold'
	Peperomia obtusifolia 'Sensation'	*Peperomia obtusifolia* 'Sensation'	*Philodendron elegans*
	Philodendron elegans	*Philodendron elegans*	*Philodendron wendlandii*
	Pleomele reflexa	*Pleomele reflexa*	*Pleomele reflexa*
	Polyscias guilfoylei	*Polyscias guilfoylei*	*Polyscias guilfoylei*
	Polyscias paniculata 'Variegata'	*Rhoeo discolor*	*Polyscias paniculata* 'Variegata'
	Rhapis excelsa	*Sansevieria trifasciata* 'Laurentii'	*Schefflera arboricola*
	Rhoeo discolor	*Schefflera arboricola*	*Scindapsus aureus*
	Scindapsus aureus	*Scindapsus aureus*	*Scirpus cernuus*
	Scirpus cernuus	*Scirpus cernuus*	*Syngonium wendlandii*
		Tacca chantrieri	*Tacca chantrieri*
			Tillandsia stricta

Table 22. Classification of foliage plants based on air pollution tolerance (Contd.,)

Susceptibility levels	Seasons		
	March-April	June-July	October-November
Susceptible (≤10)	*Aglaonema pseudobracteatum*	*Aglaonema pseudobracteatum*	*Aglaonema pseudobracteatum*
	Chlorophytum 'Charlotte'	*Cyperus alternifolius*	*Chlorophytum* 'Charlotte'
	Kalanchoe blossfeldiana	*Kalanchoe blossfeldiana*	*Codiaeum variegatum* 'Punctatum aureum'
	Ophiopogon jaburan 'Variegata'	*Nephrolepis exaltata*	*Costus curvibracteatus*
	Peperomia clusiifolia	*Peperomia clusiifolia*	*Kalanchoe blossfeldiana*
	Philodendron 'Ceylon Gold'	*Philodendron* 'Ceylon Gold'	*Nephrolepis exaltata*
	Sansevieria trifasciata 'Hahnii'	*Polyscias paniculata* 'Variegata'	*Rhapis excelsa*
	Sansevieria trifasciata 'Laurentii'	*Rhapis excelsa*	*Rhoeo discolor*
	Schefflera arboricola	*Sansevieria trifasciata* 'Hahnii'	*Sansevieria trifasciata* 'Hahnii'
	Spathiphyllum wallisii	*Spathiphyllum wallisii*	*Sansevieria trifasciata* 'Laurentii'
	Syngonium podophyllum	*Syngonium podophyllum*	*Spathiphyllum wallisii*
	Syngonium wendlandii	*Syngonium wendlandii*	*Syngonium podophyllum*
	Tillandsia stricta	*Tillandsia stricta*	*Tradescantia spathacea* 'Sitara'
	Tradescantia spathacea 'Sitara'	*Tradescantia spathacea* 'Sitara'	*Zamioculcas zamiifolia*
	Zamioculcas zamiifolia	*Zamioculcas zamiifolia*	

It was observed that *Anthurium andreanum* 'Bonina', *Calathea zebrina* and *Dracaena* 'Purple Compacta' had the highest APTI values irrespective of the seasons. In all the seasons, *Aglaonema pseudobracteatum*, *Kalanchoe blossfeldiana*, *Sansevieria trifasciata* 'Hahnii', *Spathiphyllum wallisii*, *Syngonium podophyllum*, *Tradescantia spathacea* 'Sitara' and *Zamioculcas zamiifolia* were found to be the most susceptible.

4.2.7. Transpiration rate

Though transpiration rate was not taken into account for calculating APTI, it was recorded to observed that the species were significantly different in their transpiration rate (Table 23). *Polyscias paniculata* 'Variegata' (2.38 mmol) and *Dracaena marginata* (2.36 mmol) were the species that had the highest transpiration rate and they were closely followed by *Cyperus alternifolius* and *Ficus benjamina* (2.11 mmol). The lowest rate was recorded in *Codiaeum variegatum* 'Delaware' (0.071 mmol) and *Sansevieria trifasciata* 'Laurentii' (0.077 mmol) which were on par.

Table 23. Transpiration rate of foliage plants

S.No	Plant Species	Transpiration rate (mmol)	S.No	Plant Species	Transpiration rate (mmol)
1	*Aglaonema nitidum* 'Curtisii'	0.379	27	*Ophiopogon jaburan*	0.595
2	*Aglaonema pseudobracteatum*	0.509	28	*Ophiopogon jaburan* 'Variegata'	0.736
3	*Alpinia zerumbet* 'Variegata'	0.835	29	*Peperomia clusiifolia*	0.738
4	*Anthurium andreanum* 'Bonina'	0.133	30	*Peperomia obtusifolia*'Sensation'	1.250
5	*Anthurium crystallinum*	0.661	31	*Philodendron* 'Ceylon Gold'	1.030
6	*Asparagus setaceus*	1.150	32	*Philodendron elegans*	1.350
7	*Begonia rex*	0.998	33	*Philodendron wendlandii*	0.878
8	*Calathea ornata* 'Roseo-lineata'	1.440	34	*Pleomele reflexa*	0.748
9	*Calathea zebrina*	2.040	35	*Polyscias guilfoylei*	0.626
10	*Chlorophytum* 'Charlotte'	0.722	36	*Polyscias paniculata*	2.380
11	*Chrysalidocarpus lutescens*	0.305	37	*Rhapis excelsa*	0.638
12	*Chrysothemis pulchella*	0.630	38	*Rhoeo discolor*	0.288
13	*Codiaeum variegatum* 'Delaware'	0.071	39	*Sansevieria trifasciata* 'Hahnii'	0.080
14	*Codiaeum variegatum* 'Punctatum aureum'	0.435	40	*Sansevieria trifasciata* 'Laurentii'	0.077
15	*Costus curvibracteatus*	0.613	41	*Schefflera arboricola*	0.718
16	*Cyperus alternifolius*	2.110	42	*Scindapsis aureus*	0.726
17	*Dieffenbachia amoena*	1.170	43	*Scirpus cernuus*	0.395
18	*Dracaena marginata*	2.360	44	*Spathiphyllum wallisii*	1.580
19	*Dracaena* 'Purple Compacta'	1.340	45	*Syngonium podophyllum*	2.040
20	*Dracaena sanderiana*	1.580	46	*Syngonium wendlandii*	1.590
21	*Ficus benjamina*	2.110	47	*Tacca chantrieri*	0.382
22	*Homalomena wallisii*	1.540	48	*Tillandsia stricta*	0.509
23	*Iris innominata*	1.440	49	*Tradescantia spathacea* 'Sitara'	0.601
24	*Kalanchoe blossfeldiana*	0.564	50	*Zamioculcas zamiifolia*	0.325
25	*Licuala grandis*	0.852		**CD (0.05)**	**0.0158**
26	*Nephrolepis exaltata*	1.550			

4.3. Evaluation under indoor conditions

Among the fifty foliage plant species evaluated in two growing systems, ten species were selected based on their APTI values (two species from each category) to evaluate their performance under different indoor light levels. Plant characters, longevity, symptoms of damage and pest and disease incidence were observed and presented here under.

Plant characters like height, number of leaves and plant spread were recorded at fortnightly interval for a period of 70 days after which 50 per cent of plants showed different signs of damage. Some of the species had to be shifted before this. The other characters like leaf area, leaf length and breadth, internodal length and petiole length and girth of indoor foliage pants were recorded at monthly interval for three months. Observations on *Ficus benjamina* in low light level zone was taken only for the first month after which it had to be shifted. *Anthurium andreanum* 'Bonina', *Chrysalidocarpus lutescens* and *Ficus benjamina* in supplementary light zone and all the plants in low light zone except *Scindapsus aureus* were to be shifted during the third month of observation.

4.3.1. Plant characters

4.3.1.1. Plant height

The plants kept in air conditioned zone with supplementary light during first two fortnights had the maximum height and it was on par with low light zone during the second fortnight. *Chrysalidocarpus lutescens* (93.3 and 102.3 cm in 15 and 30 days after placement respectively) in high light zone and *Ficus benjamina* (99.3 and 106.3 cm in 15 and 30 days after placement respectively) in air conditioned zone with supplementary light had the highest plant height during this period.

During the third fortnight, plants kept in medium and high light level zones produced maximum height and it was on par with air conditioned zone. *Chrysalidocarpus lutescens* (73.0 cm), *Rhapis excelsa* (45.3 cm), *Schefflera arboricola* (44.7 cm) and *Syngonium podophyllum* (44.4 cm) in medium light level zone; *Chrysalidocarpus lutescens* and *Ficus benjamina* in high light and also in air conditioned zone with supplementary light; and *Schefflera arboricola* in air conditioned zone with supplementary light had the maximum plant height. During last fortnight, *Syngonium podophyllum* (46.7, 38.1, 46, 40.3 cm in ML, HL, SL and AC zones respectively) and *Schefflera arboricola* (45.7, 37.8, 43.2, 58 cm in ML, HL, SL and AC zones respectively) in all light levels except in low light, *Ficus benjamina* and *Philodendron elegans* in medium, high and air conditioned zone with supplementary light, *Chrysalidocarpus lutescens* and *Rhapis excelsa* in medium light and high light zone and *Spathiphyllum wallisii* in medium and air conditioned zone with supplementary light produced the maximum height.

4.3.1.2. Number of leaves

Among the light levels, plants kept in air conditioned zone with supplementary light was observed to produce more number of leaves throughout the period of observation and it was on par with medium and high light zones during both third and fourth fortnight. Among the interactions, *Ficus benjamina* (220, 198, 190 and 133 in 15, 30, 45 and 60 days of observation respectively) kept in air conditioned zone with supplementary light produced more number of leaves throughout the period of observation and it was on par with *Ficus benjamina* in medium (68) and high light (105) zones and *Schefflera arboricola* in air conditioned zone with supplementary light (41) during the last fortnight.

4.3.1.3. Plant spread

The spread of indoor foliage plants was recorded in two ways viz., north-south and east-west and the results were presented in Table 24.

4.3.1.3.1. North-south

Among the light levels, plants kept in medium and high light levels were good and they were on par with the air conditioned zone with supplementay light during the last fortnight.

While considering the interaction effect, it was observed that each species had performed well atleast in any one light zone except *Anthurium andreanum* 'Bonina' during third fortnight whereas during the last fortnight it also performed well in high light zone (21 cm). Other combinations produced the highest spread during third fortnight were *Rhapis excelsa* (in all light levels), *Schefflera arboricola* (except in low light), *Syngonium podophyllum* (except in high light zone), *Chrysalidocarpus lutescens* and *Spathiphyllum wallisii* (in all light levels except in low light and supplementary light levels), *Philodendron* 'Ceylon Gold' and *Philodendron elegans* (except low and medium light zones) and *Scindapsus aureus* (36.1 cm) in high light level were the right combinations that produced maximum plant spread. During last fortnight, *Philodendron elegans*, *Schefflera arboricola*, *Spathiphyllum wallisii* and *Syngonium podophyllum* had the highest plant spread in all light levels except in low light. It was on par with *Scindapsus aureus* in all light levels except in supplementary light, *Ficus benjamina* and *Philodendron* 'Ceylon Gold' except in low light and supplementary light. *Chrysalidocarpus lutescens* and *Rhapis excelsa* were good in medium and high light levels with respect to plant spread in north-south direction.

4.3.1.3.2. East-west

The plant spread in east-west direction of foliage plants kept in air conditioned zone with supplementary light during first fortnight and medium light during the rest of the period was the maximum. The air conditioned zone with supplementary light was on par with the highest during second and third fortnights and high light zone during the last fortnight. From the interaction, during third fortnight, *Rhapis excelsa* and *Syngonium podophyllum* in all light levels had the highest plant spread. They were on par with *Philodendron* 'Ceylon Gold', *Philodendron elegans*, *Schefflera arboricola* and *Spathiphyllum podophyllum* in which the spread was more in all light levels except in low light. In *Chrysalidocarpus lutescens* and *Ficus benjamina* also, the spread was good in all levels except low light and supplementary light and *Scindapsus aureus* except in high and supplementary light and *Anthurium andreanum* 'Bonina' in air conditioned zone with supplementary light. During the last fortnight, the following combinations produced the highest plant spread in this direction and they were on par. *Scindapsus aureus* (in all light levels), *Philodendron elegans*, *Schefflera arboricola*, *Spathiphyllum wallisii* and *Syngonium podophyllum* excelled except in low light, *Anthurium andreanum* 'Bonina', *Ficus benjamina* and *Philodendron* 'Ceylon Gold' except in low and supplementary light and *Chrysalidocarpus lutescens* and *Rhapis excelsa* had the highest spread in medium and high light levels.

4.3.1.4. Internodal length

Internodal length was recorded only in six foliage plants as the other four did not have measurable internodes. The plants in air conditioned zone with supplementary light produced the longest internodes during second month and it was on par with medium light level zone during the third month. *Scindapsus aureus* (7.85 cm) when kept in low light zone and *Syngonium podophyllum* (12.4 cm) kept under air conditioned zone with supplementary light were observed to have maximum internodal length and *Schefflera arboricola* (0.80 cm) in supplementary light level had the least.

Table 24. Plant characters of selected foliages under different indoor light conditions

S. No.	Plant species	Levels of light	Plant height (cm)				No. of leaves				Plant spread (North-South) (cm)				Plant spread (East-West) (cm)				Internodal length (cm)		
			Fortnights				Fortnights				Fortnights				Fortnights				Months		
			I	II	***III	***IV	**I	**II	***III	***IV	I	***II	***III	***IV	I	***II	***III	***IV	**I	***II	***III
1.	*Anthurium andreanum* 'Bonina'	LL	13.3	11.2	0.0	0.0	11	8	0	0	16.9	17.6	0.0	0.0	20.5	18.4	0.0	0.0	-	-	-
		ML	17.4	16.6	17.3	17.3	9	9	10	9	18.3	19.7	18.4	19.4	19.3	20.6	21.4	22.4	-	-	-
		HL	14.8	13.3	15.3	16.0	13	12	14	15	20.8	21.8	22.6	21.0	15.0	14.9	14.8	16.5	-	-	-
		SL	13.9	13.4	0.0	0.0	9	10	0	0	17.3	8.3	0.0	0.0	17.5	9.4	0.0	0.0	-	-	-
		A/C	17.6	18.4	17.5	17.0	7	7	7	6	18.5	17.2	17.6	16.0	22.9	23.4	26.6	28.1	-	-	-
2.	**Chrysalidocarpus lutescens*	LL	67.0	72.9	0.0	0.0	5	6	0	0	43.1	55.3	0.0	0.0	48.6	64.0	0.0	0.0	-	-	-
		ML	52.9	72.7	73.0	75.3	3	9	9	5	38.9	45.7	59.0	63.2	47.0	53.4	53.0	52.8	-	-	-
		HL	93.3	102.3	101.8	109.3	5	9	9	5	47.2	49.0	76.0	82.7	51.7	53.8	55.9	58.3	-	-	-
		SL	63.9	67.7	25.2	24.9	4	7	3	3	43.3	47.8	22.6	22.8	46.4	54.2	20.6	20.7	-	-	-
		A/C	65.5	67.9	60.4	0.0	5	5	5	0	56.0	62.1	67.0	0.0	63.6	60.6	60.0	0.0	-	-	-
3.	*Ficus benjamina*	LL	75.9	75.9	0.0	0.0	18	22	0	0	35.7	35.7	0.0	0.0	36.3	36.3	0.0	0.0	3.3	0.0	0.0
		ML	36.8	36.2	38.3	38.0	57	50	49	68	27.7	25.5	31.3	30.8	31.3	30.2	44.9	44.7	1.9	2.4	1.4
		HL	62.2	64.5	61.3	64.8	86	82	81	105	30.0	32.3	27.6	28.5	27.7	30.7	36.2	28.2	1.8	2.4	2.2
		SL	48.6	49.7	0.0	0.0	116	93	0	25	31.9	32.7	0.0	0.0	31.8	32.0	0.0	0.0	2.2	1.4	0.0
		A/C	99.3	106.3	108.3	105.6	220	198	190	133	35.8	36.7	36.2	35.6	45.9	46.6	43.1	42.8	3.5	3.3	1.9
4.	*Philodendron* 'Ceylon Gold'	LL	17.6	15.5	0.0	0.0	7	11	0	0	25.2	24.3	0.0	0.0	24.2	22.5	0.0	0.0	1.1	1.3	0.0
		ML	16.8	16.9	20.8	29.0	10	15	15	11	25.3	26.6	26.6	26.5	32.4	32.5	32.5	29.6	1.6	1.1	2.0
		HL	21.3	23.8	21.9	23.4	11	11	11	12	28.1	30.0	35.0	34.0	25.2	30.0	28.6	34.5	1.4	1.0	0.9
		SL	22.3	20.6	22.1	9.4	9	8	9	5	30.0	27.6	32.4	14.8	30.5	32.3	27.4	13.4	2.0	1.6	0.9
		A/C	23.7	28.5	25.1	26.2	13	12	12	13	37.5	38.5	34.7	36.0	27.4	34.0	36.9	36.9	1.9	3.3	3.0
5.	*Philodendron elegans*	LL	20.9	17.9	0.0	0.0	5	3	0	0	43.5	43.7	0.0	0.0	28.4	35.6	0.0	0.0	1.1	2.9	0.0
		ML	25.3	25.9	25.7	36.4	9	7	8	8	37.0	28.5	28.8	36.3	34.5	36.3	42.6	45.8	1.6	2.0	5.5
		HL	18.3	21.7	26.2	30.8	4	5	6	6	30.8	32.9	35.6	39.6	26.0	31.6	34.7	33.2	1.4	3.5	4.0
		SL	19.8	20.4	18.5	18.7	5	5	4	4	41.7	39.5	33.2	30.1	38.7	32.3	38.8	31.9	2.5	3.3	2.1
		A/C	30.5	33.2	32.4	35.7	6	5	6	6	44.5	43.5	51.4	47.8	41.5	46.3	56.0	52.7	1.9	6.1	5.5

Table 24. Plant characters of selected foliages under different indoor light conditions (Contd.,)

			I	II	***III	***IV	**I	**II	***III	***IV	I	***II	***III	***IV	I	***II	***III	***IV	**I	***II	***III
6.	*Rhapis excelsa	LL	36.8	33.0	37.3	0.0	12	16	10	0	39.4	45.0	41.8	0.0	38.7	42.0	44.8	0.0	-	-	-
		ML	43.9	40.8	45.3	47.0	11	14	14	12	42.0	45.9	45.0	48.4	41.2	41.5	40.5	41.0	-	-	-
		HL	25.0	21.0	30.5	31.4	5	13	7	7	41.9	43.6	40.9	43.0	38.3	41.7	43.1	43.7	-	-	-
		SL	35.6	26.0	31.2	18.8	10	11	10	5	40.9	40.9	42.3	22.4	39.9	40.9	44.4	22.3	-	-	-
		A/C	36.0	37.5	42.1	0.0	8	10	7	0	36.1	48.0	42.0	0.0	35.3	43.8	46.1	0.0	-	-	-
7.	*Schefflera arboricola*	LL	45.3	43.7	0.0	0.0	30	31	0	0	39.3	43.0	0.0	0.0	37.1	43.6	0.0	0.0	1.1	1.1	0.0
		ML	46.6	41.2	44.7	45.7	31	26	26	32	35.1	36.3	36.1	41.9	30.0	33.1	31.5	35.8	1.4	4.2	2.1
		HL	26.5	25.4	34.5	37.8	14	14	14	18	40.6	39.3	41.3	38.2	37.6	39.5	35.6	40.4	1.3	1.0	1.7
		SL	43.3	42.4	42.2	43.2	43	38	35	38	44.0	43.3	42.9	44.5	42.5	39.7	39.1	42.1	1.6	0.8	0.4
		A/C	53.5	59.0	57.4	58.0	50	48	47	41	40.7	39.6	39.6	44.2	38.3	43.2	43.2	49.3	1.3	1.3	1.6
8.	*Scindapsus aureus*	LL	21.3	57.7	19.6	23.2	13	13	14	13	28.3	24.8	31.1	32.7	28.5	26.4	34.0	33.3	8.3	7.9	8.3
		ML	20.5	60.9	16.2	16.2	13	14	16	14	31.1	32.6	26.0	24.5	32.4	34.4	39.3	42.9	6.4	4.3	5.8
		HL	22.7	39.9	20.0	19.0	12	12	13	15	24.0	26.4	36.1	39.5	28.6	28.8	23.7	22.0	5.9	5.5	4.0
		SL	18.6	18.1	17.3	17.2	8	9	8	8	20.8	19.5	19.0	21.2	21.4	21.3	20.6	18.0	5.8	5.7	3.3
		A/C	17.6	18.9	21.4	18.4	14	15	15	15	28.0	28.4	25.5	28.8	35.3	38.5	40.4	36.2	6.3	5.8	6.8
9.	*Spathiphylium wallisii	LL	34.3	35.7	0.0	0.0	5	7	0	0	23.0	25.6	0.0	0.0	30.4	27.1	0.0	0.0	-	-	-
		ML	29.3	27.4	35.2	37.3	7	11	7	9	31.9	32.3	38.0	39.0	26.5	36.5	30.9	30.7	-	-	-
		HL	35.3	23.1	30.0	28.1	6	10	6	6	45.6	27.0	36.6	22.3	38.4	37.6	36.7	41.9	-	-	-
		SL	24.1	25.8	22.3	23.2	8	7	8	8	21.8	26.9	26.8	27.5	33.1	21.7	27.2	30.8	-	-	-
		A/C	38.6	39.0	40.1	39.5	7	7	8	9	36.0	38.4	35.9	37.0	46.0	43.6	46.5	48.0	-	-	-
10.	*Syngonium podophyllum*	LL	37.2	43.7	42.7	0.0	7	8	8	0	35.7	44.8	36.7	0.0	28.0	29.8	37.1	0.0	6.3	6.2	0.0
		ML	40.5	42.9	44.4	46.7	15	17	17	14	44.1	35.0	35.0	41.0	42.2	45.8	45.8	49.6	4.9	3.5	8.7
		HL	19.2	23.8	31.1	38.1	4	6	7	7	18.9	20.7	23.5	26.4	20.6	24.0	26.4	35.0	5.7	1.2	3.1
		SL	31.8	37.0	41.5	46.0	9	10	10	11	38.5	37.7	42.0	42.7	42.6	44.2	50.0	48.0	4.5	5.7	3.4
		A/C	35.9	39.1	39.6	40.3	10	13	12	15	37.5	33.8	30.3	39.2	46.3	53.4	55.0	53.1	9.5	12.4	12.8
CD (0.05)	Species		6.46	8.90	0.17	0.24	0.72	0.74	0.13	0.24	6.11	0.13	0.17	0.26	6.90	0.14	0.16	0.26	0.28	0.11	0.19
	Light levels		4.57	6.29	0.12	0.17	0.50	0.52	0.09	0.17	NS	NS	0.12	0.18	4.88	0.10	0.11	0.18	NS	0.10	0.17
	Species x light levels		14.46	19.91	0.38	0.55	1.61	1.66	0.30	0.53	NS	NS	0.39	0.58	NS	NS	0.37	0.58	NS	0.26	NS

LL-Low light (<800 lux), ML- Medium light (800-2000 lux), HL- High light (>2000 lux), SL- Supplementary light without a/c (800-2000 lux), AC- Supplementary light with a/c (800-2000 lux)

* Plants with no internodes, **Data subjected to square root transformation before analysis, ***Data subjected to logarithmic transformation before analysis

4.3.2. Leaf characters

4.3.2.1. Leaf area

In the first month of observation, the light levels and their interaction with species had no significant effect. During second month, the high light level and air conditioned zone with supplementary light were found superior compared to other light levels. Interaction effects showed that *Chrysalidocarpus lutescens*, *Rhapis excelsa* (in all light levels), *Schefflera arboricola* (except in supplementary light zone), *Philodendron elegans* in low light, supplementary and air conditioned with supplementary light zone, *Spathiphyllum wallisii* in high light zone and air conditioned with supplementary zone and *Syngonium podophyllum* in supplementary light zone recorded the highest leaf area and they were on par.

During third month, the plants in medium light, high light and air conditioned zone with supplementary light recorded the highest leaf area while the interaction effects were not significant.

4.3.2.2. Leaf length

The plants kept in light levels of medium, high and air conditioned with supplementary light zones had the highest leaf length than others. During first month, *Chrysalidocarpus lutescens* in low light (43.4 cm), high light (45.3cm) and supplementary light zone (43.2 cm) had the highest leaf length and the lowest was obtained in *Ficus benjamina* in all light zones. During the second month, *Chrysalidocarpus lutescens* had the highest leaf length in all the light levels.

4.3.2.3. Leaf breadth

Leaf breadth of foliage plants in zones of high and air conditioned zone with supplementary light recorded the maximum and medium light level zone was on par with this during the third month. *Chrysalidocarpus lutescens* had the highest leaf breadth in all light levels.

4.3.2.4. Petiole length

Low light, supplementary light, air conditioned zone with supplementary light were the good light conditions where the plants had the highest petiole length during the first month, whereas during the third month plants in medium, high, air conditioned with supplementary light zones showed maximum length of petiole. Among the interactions, *Chrysalidocarpus lutescens* in low light (34.9 cm), high light (27.9 cm) and air conditioned

Table 25. Leaf characters of selected foliages under different indoor light conditions

S. No.	Plant species	Levels of light	Leaf area (sq. cm)			Leaf length (cm)			Leaf breadth (cm)			Petiole length (cm)			Petiole girth (cm)		
			Months			Months			Months			Months			Months		
			**I	***II	***III	**I	***II	***III	**I	***II	***III	**I	***II	***III	**I	***II	***III
1.	*Anthurium andreanum* 'Bonina'	LL	24.00	15.63	0.00	8.2	6.7	0.0	4.2	3.6	0.0	7.8	6.3	0.0	0.4	0.4	0.0
		ML	31.82	19.68	32.81	9.7	7.8	8.5	4.8	4.2	5.4	12.4	11.0	9.9	0.6	0.4	0.5
		HL	26.63	32.20	30.41	8.9	8.7	8.8	4.8	5.1	4.8	9.5	11.7	10.1	0.5	0.6	0.7
		SL	21.49	17.05	0.00	7.5	4.6	0.0	4.7	2.7	0.0	8.6	6.7	0.0	0.6	0.3	0.0
		A/C	44.16	37.45	34.62	11.1	10.3	9.6	5.7	5.8	5.1	13.4	11.6	11.5	0.6	0.7	0.7
2.	*Chrysalidocarpus lutescens*	LL	262.05	251.04	0.00	43.4	43.8	0.0	52.7	53.5	0.0	34.9	25.7	0.0	1.3	1.2	0.0
		ML	237.76	178.80	224.58	38.3	38.9	34.9	42.6	43.8	35.8	23.3	24.5	23.4	1.3	1.3	1.0
		HL	374.30	251.40	298.87	45.3	44.7	43.1	56.6	55.3	52.1	27.9	29.9	48.1	1.3	1.7	1.3
		SL	211.35	248.82	0.00	43.2	42.2	0.0	52.3	50.4	0.0	26.7	27.0	0.0	1.2	1.2	0.0
		A/C	196.65	276.78	255.84	38.6	44.9	38.5	43.2	55.8	43.0	28.9	21.6	28.4	0.9	1.5	1.2
3.	*Ficus benjamina*	LL	11.66	0.00	0.00	6.5	0.0	0.0	2.9	0.0	0.0	1.1	0.0	0.0	0.2	0.0	0.0
		ML	9.84	10.59	11.99	6.0	6.0	6.2	2.8	2.6	2.5	0.8	1.5	1.1	0.2	0.3	0.3
		HL	8.99	9.94	8.54	5.9	5.5	5.2	2.7	2.4	2.6	1.1	1.0	0.8	0.3	0.3	0.3
		SL	9.59	4.03	0.00	5.9	2.4	0.0	2.8	1.3	0.0	1.0	0.5	0.0	0.3	0.2	0.0
		A/C	10.81	15.59	9.03	7.0	7.5	6.7	2.9	3.4	2.9	1.0	1.0	1.0	0.3	0.3	0.3
4.	*Philodendron* 'Ceylon Gold'	LL	59.29	51.37	0.00	14.2	13.0	0.0	5.7	5.0	0.0	7.1	7.4	0.0	1.4	1.3	0.0
		ML	112.20	53.46	72.62	18.9	13.2	16.4	6.9	4.9	5.4	8.4	6.9	7.5	1.9	1.2	1.6
		HL	56.82	58.44	84.86	15.7	15.7	18.2	5.9	5.6	6.1	8.4	7.0	9.1	1.2	1.2	1.6
		SL	87.96	77.80	39.21	18.4	16.3	7.8	6.4	6.0	3.3	8.5	9.0	4.9	1.5	1.4	0.8
		A/C	63.25	94.55	117.02	14.5	18.0	20.3	5.9	6.7	7.8	8.4	9.5	9.2	1.2	1.5	1.9
5.	*Philodendron elegans*	LL	204.23	147.37	0.00	22.0	18.5	0.0	5.7	14.3	0.0	7.1	16.4	0.0	1.4	1.7	0.0
		ML	103.33	72.42	122.96	15.4	15.0	16.9	6.9	9.8	11.6	8.4	14.6	20.6	1.9	1.2	1.7
		HL	122.83	50.66	171.10	16.8	12.8	20.9	5.9	7.2	13.9	8.4	9.8	22.4	1.2	1.2	2.0
		SL	128.76	175.02	75.73	18.1	19.7	8.6	9.6	15.0	5.9	12.5	16.3	8.8	1.7	1.7	0.9
		A/C	235.06	220.25	176.92	24.0	21.3	23.0	5.9	17.8	19.2	8.4	16.6	20.0	1.2	1.9	2.3

Table 25. Leaf characters of selected foliages under different indoor light conditions (Contd.,)

			**I	***II	***III	**I	***II	***III	**I	***II	***III	**I	***II	***III	**I	***II	***III
6.	*Rhapis excelsa*	LL	152.55	114.18	0.00	18.0	16.0	0.0	14.2	11.8	0.0	17.7	12.3	0.0	0.6	0.5	0.0
		ML	177.72	114.18	199.40	17.9	15.8	18.5	15.0	11.8	16.6	11.5	14.3	15.0	0.6	0.5	0.4
		HL	166.73	122.26	144.64	15.8	15.4	14.3	11.8	11.8	12.0	10.4	10.7	10.8	0.4	0.4	0.8
		SL	98.88	177.32	101.22	19.1	18.1	9.0	15.0	15.0	8.0	16.5	16.4	8.0	0.5	0.6	0.3
		A/C	151.31	235.00	83.16	18.3	19.2	6.9	15.2	14.0	8.2	19.5	19.2	8.8	0.4	0.4	0.3
7.	*Schefflera arboricola*	LL	122.20	108.04	0.00	12.4	11.8	0.0	16.5	14.3	0.0	10.8	10.2	0.0	0.8	0.9	0.0
		ML	100.00	121.76	108.08	12.1	11.3	11.4	14.0	14.3	14.0	9.7	11.5	12.5	1.0	0.9	0.8
		HL	113.00	131.16	81.44	12.2	11.1	10.7	15.0	14.5	12.5	11.9	10.6	11.5	1.0	1.0	1.0
		SL	115.48	86.96	40.64	11.9	11.8	5.4	14.0	11.3	6.5	11.6	11.8	4.8	0.8	0.9	0.5
		A/C	117.12	106.88	148.00	12.3	12.3	12.4	14.8	14.8	16.3	10.7	11.1	10.9	1.0	0.8	0.5
8.	*Scindapsus aureus*	LL	50.64	35.44	52.51	9.9	8.5	9.9	7.7	6.6	7.7	4.2	4.7	4.5	1.1	0.8	1.1
		ML	41.10	34.77	32.17	9.6	9.0	7.6	6.5	5.9	5.2	4.6	4.3	5.2	0.9	0.8	0.9
		HL	30.84	40.52	32.01	8.0	9.6	8.5	5.5	6.5	6.0	4.2	4.7	5.1	0.7	1.2	1.0
		SL	35.23	31.81	12.19	8.9	8.3	3.8	5.6	6.1	2.6	5.4	5.5	3.4	1.0	0.9	0.5
		A/C	36.10	28.88	42.29	9.5	7.8	9.7	6.6	5.5	6.6	4.3	4.6	6.0	1.0	0.9	1.2
9.	*Spathiphyllum wallisii*	LL	84.74	73.93	0.00	19.9	19.8	0.0	6.0	6.4	0.0	24.1	16.2	0.0	0.9	1.3	0.0
		ML	95.33	70.88	113.57	20.6	19.7	20.4	7.2	7.0	7.2	15.8	13.5	16.9	1.5	1.4	1.4
		HL	107.51	119.33	145.52	22.0	22.3	25.9	7.1	7.4	8.9	16.5	15.8	18.9	1.3	1.6	1.7
		SL	56.58	45.48	25.12	16.4	15.1	8.0	5.8	5.0	2.8	12.3	12.0	8.6	1.0	1.1	0.6
		A/C	108.14	100.44	123.21	21.6	21.5	22.0	7.5	7.5	7.9	18.3	18.3	19.0	1.8	1.6	2.0
10.	*Syngonium podophyllum*	LL	151.02	85.59	0.00	16.9	15.5	0.0	11.1	8.2	0.0	26.3	18.1	0.0	1.2	0.9	0.0
		ML	76.65	69.49	129.17	14.9	14.6	20.3	7.7	7.8	10.6	15.6	21.2	20.7	0.8	0.5	1.5
		HL	66.12	63.22	95.12	14.5	12.5	15.1	7.4	7.5	8.0	13.1	13.2	17.9	0.8	0.7	1.4
		SL	152.11	139.84	36.24	18.7	19.9	10.2	11.6	9.7	5.9	23.7	25.5	12.8	1.2	1.4	0.7
		A/C	169.59	90.20	104.70	21.0	18.0	18.5	10.8	8.6	8.7	16.6	14.2	15.3	1.2	1.2	1.3
CD (0.05)	Species		1.80	0.19	0.50	0.21	0.12	NS	0.27	0.10	0.26	0.28	0.13	0.30	0.07	0.04	0.08
	Light levels		NS	0.13	0.35	NS	0.08	0.21	NS	0.07	0.19	0.19	NS	0.21	NS	0.03	0.06
	Species x light levels		NS	0.44	NS	0.48	0.28	NS	NS	0.23	NS	0.62	NS	NS	0.17	NS	NS

LL-Low light (<800 lux), ML- Medium light (800-2000 lux), HL- High light (>2000 lux), SL- Supplementary light without a/c (800-2000 lux), AC- Supplementary light with a/c (800-2000 lux)

* Plants with no internodes, **Data subjected to square root transformation before analysis, ***Data subjected to logarithmic transformation before analysis

zone with supplementary light (28.9 cm) levels had the highest petiole length. *Ficus benjamina* in all light levels produced the shortest petiole.

4.3.2.5. Petiole girth

The plants kept under high light level and air conditioned zone with supplementary light had the highest petiole girth which was on par with supplementary light level and medium light level during second and third month respectively. *Philodendron* 'Ceylon Gold' and *Philodendron elegans* had the maximum petiole girth in medium and supplementary light levels respectively and *Spathiphyllum wallisii* in air conditioned zone with supplementary light. *Ficus benjamina* had the least petiole girth in all light levels.

4.3.3. Indoor life of foliage plants

Indoor life of foliage plants was determined by counting the number of days the plants were kept in different indoor light conditions without any symptoms/signs of damage and the species differed significantly (Table 26).

The plants which did not produce any symptoms for more number of days under different indoor light conditions was *Scindapsus aureus*, followed by *Ficus benjamina* and *Syngonium podophyllum* and the plants that produced the symptoms of damage within a short span were *Philodendron* 'Ceylon Gold', *Philodendron elegans* and *Spathiphyllum wallisii.*

When the light conditions were compared, the zone with medium light intensity (800-2000 lux) and the air conditioned zone with supplementary light (800-2000 lux) were found good to keep the plants without any sign of damage for more number of days.

The interaction between the species and light levels also produced significant results. *Anthurium andreanum* 'Bonina' and *Syngonium podophyllum* in air conditioned zone with supplementary light (800-2000 lux), *Ficus benjamina* and *Schefflera arboricola* in medium light zone (800-2000 lux) and *Scindapsus aureus* in both medium light and air conditioned zone with supplementary light produced no symptoms for a maximum of 70 days after which the whole lot need to be shifted as 50 per cent of plants showed symptoms of damage. *Ficus benjamina* in high light zone (>2000 lux) lasted only for 7 days.

4.3.4. Major symptoms/signs of damage

The foliage plants at different light conditions showed different kinds of symptoms/signs of damage when kept for long period. Symptoms were observed at every part of the plant from leaf tip to main stalk. It ranged from yellowing, wilting, leaf drop, leaf

Table 26. Indoor life, damage symptoms, pests and diseases of selected foliage plants under indoor conditions

S. No.	Plant species	Levels of light	Indoor life (days)	Symptoms of damage	Pests & Diseases observed
1.	*Anthurium andreanum* 'Bonina'	LL	18	Tip brown, Yellowish green, Leaf drying, bud drop, yellowish midrib	Nil
		ML	13	tip brown, leaf drying	Nil
		HL	18	Tip brown, Yellowish green, Leaf drying	Nil
		SL	18	tip brown, tip yellow, leaf drying	Nil
		AC	70	no symptoms	Nil
2.	*Chrysalidocarpus lutescens*	LL	15	Leaves weak and develop tenderness, drying	Leaf eating caterpillars
		ML	26	tip brown, leaf wilting	Nil
		HL	18	yellowish green, leaf wilting	Nil
		SL	18	leaf margin yellow	Nil
		AC	18	yellowing, tip brown, wilting	Mealy bug
3.	*Ficus benjamina*	LL	12	leaves all drop	Nil
		ML	70	no symptoms	Nil
		HL	7	leaf drop	Nil
		SL	24	tip brown	Nil
		AC	50	all leaves drop	Nil
4.	*Philodendron* 'Ceylon Gold'	LL	15	leaf colour fading, drying, plant wilt	Nil
		ML	22	Bending	Nil
		HL	15	Bending	Nil
		SL	14	leaf blemishes, tip scorch, yellow-green, new leaves small	Nil
		AC	14	yellow-green leaves, drying, lesion spots	Nil
5.	*Philodendron elegans*	LL	15	spots, yellowing, wilting	Nil
		ML	22	wilting	Nil
		HL	18	Bending	Nil
		SL	13	new leaves drop, yellow-green at margin, wilting	Nil
		AC	18	yellowing, margin brown, wilting, mottled	Nil

Table 26. Indoor life, damage symptoms, pests and diseases of selected foliage plants under indoor conditions (Contd.,)

S. No.	Plant species	Levels of light	Indoor life (days)	Symptoms of damage	Pests & Diseases observed
6.	*Rhapis excelsa*	LL	15	tip brown, oldest leaf dry, plant wilt	Nil
		ML	26	tip brown, leaf drying	Nil
		HL	13	tip brown, yellowish green	Nil
		SL	18	tip scorch, wilting	Nil
		AC	26	tip brown, old leaves dried and shrinken	Nil
7.	*Schefflera arboricola*	LL	15	leaf drooping, yellow-green, new leaves drop	Nil
		ML	70	no symptoms	Nil
		HL	18	Bending	Nil
		SL	18	leaves droop, shedding, drying, wilting	Nil
		AC	18	leaf drop	Nil
8.	*Scindapsus aureus*	LL	15	margin brown, leaf drying	Nil
		ML	70	no symptoms	Nil
		HL	15	tip and margin brown	Nil
		SL	14	leaf blotch, drying	Nil
		AC	70	no symptoms	Nil
9.	*Spathiphyllum wallisii*	LL	15	tip and margin brown, yellow-green	Nil
		ML	26	tip brown, margin yellow	Nil
		HL	13	margin brown, yellowish brown	Nil
		SL	13	margin brown, leaf drying	Nil
		AC	18	margin brown, yellowing	Nil
10.	*Syngonium podophyllum*	LL	26	internodes elongated, roots brown, leaves yellow-green	Nil
		ML	22	Bending	Nil
		HL	26	Bending	Nil
		SL	25	yellow-green	Mealy bug
		AC	70	no symptoms	Nil
CD (0.05)	Species		2.08		
	Light intensities		1.47		
	Species x light intensities		4.66		

Plate 11. Pests, diseases and damage symptoms observed in foliage plants under indoor conditions

11.1. Yellowing and drying of *Anthurium* leaves

11.2. Leaf drop in *Ficus*

11.3. Blackening of *Chrysalidocarpus* leaves

11.4. Leaf eating caterpillar in Chrysalidocarpus

11.5. Mealy bug attack in *Chrysalidocarpus*

11.6. Wilting of tender leaf in Philodendron elegans

11.7. Leaf burn in *Scindapsus aureus*

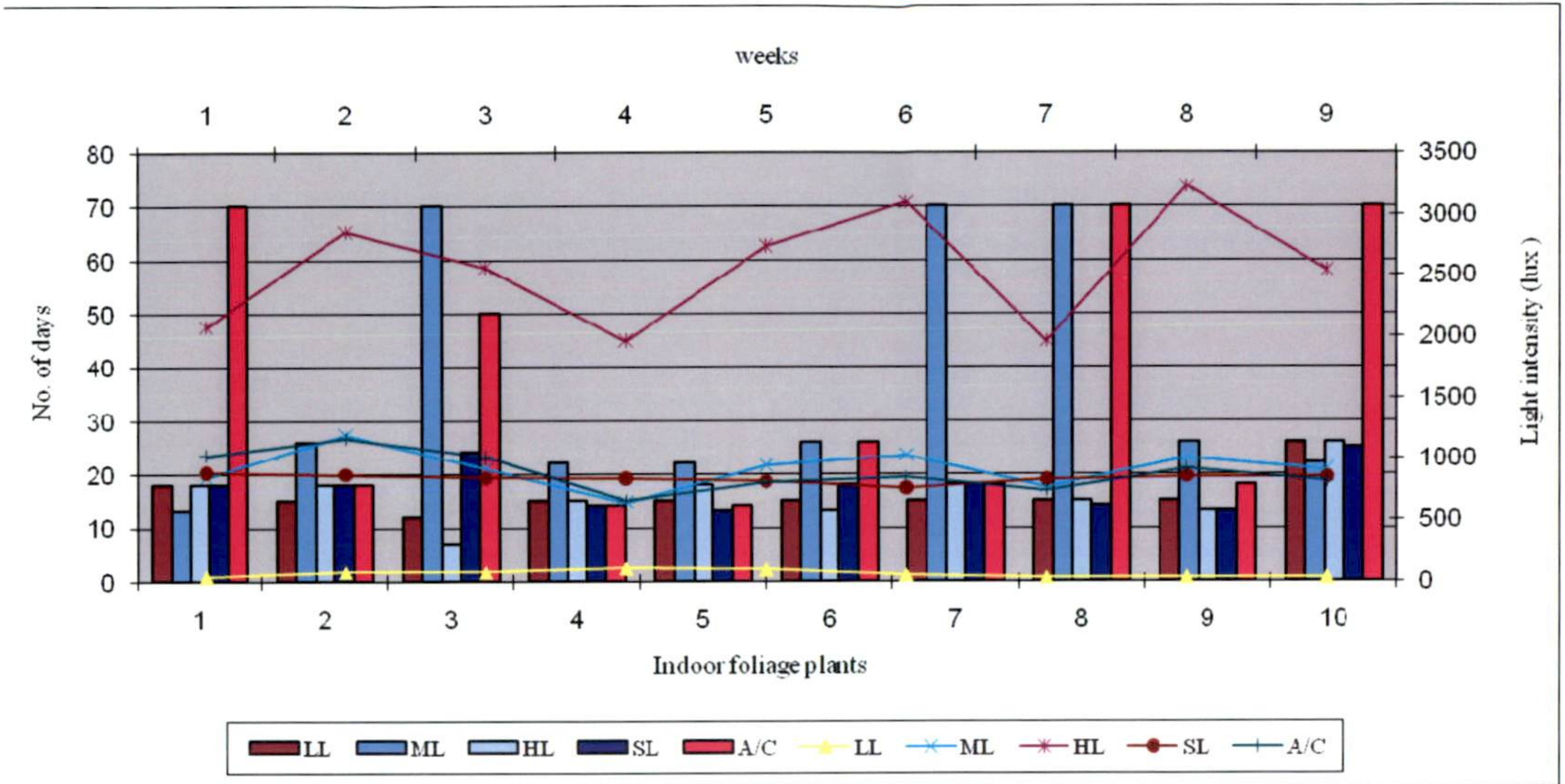
11.8. Leaf lesions in *Philodendron* 'Ceylon Gold'

11.9. Leaf discolouration and pest attack in *Spathiphyllum wallisii*

11.10. Leaf drooping in *Schefflera arboricola*

11.11. Tip burn in *Rhapis excelsa*

11.12. Yellowing and lesioning of *Syngonium* leaves



1. *Anthurium andreanum* 'Bonina', 2. *Chrysalidocarpus lutescens,* 3. *Ficus benjamina,* 4. *Philodendron* 'Ceylon Gold', 5. *Philodendron elegans,* 6. *Rhapis excelsa,* 7. *Schefflera arboricola,* 8. *Scindapsus aureus,* 9. *Spathiphyllum wallisii,* 10. *Syngonium podophyllum*

LL-Low light (<800 lux), ML- Medium light (800-2000 lux), HL- High light (>2000 lux), SL- Supplementary light (800-2000 lux), A/C- Supplementary light with air condition (800-2000 lux)

Fig 23. Longevity of selected foliage plants under different light conditions

drying, tip browning, bending and so on which were listed in Table 26 with respect to each species under different light conditions.

4.3.5. Pests & Diseases

Under indoor conditions, no serious pest and disease problems were observed commonly in all the light levels. Minor attacks by leaf eating caterpillar in Low light conditions and mealy bug in supplementary light with air conditioned zone in *Chrysalidocarpus lutescens* were observed during the period of study. In supplementary light zone, *Syngonium podophyllum* was attacked by mealy bug.

4.3.6. Plant Quality Rating

Plant quality rating was done by evaluating five parameters viz., growth and fullness, tolerance capacity, pest, diseases and other problems, general performance by 15 individuals. The APTI values were also considered for this. Selected persons were briefed with required information about the plants and allowed to observe them for a period of one week before the rating. The grades ranged from 1-10 for each character and the total for each species are presented in the table 27. In growth and fullness, *Spathiphyllum wallisii* scored the highest with 8.4 out of 10, *Scindapsus aureus* scored maximum (7.5) against tolerance capacity to different light conditions, *Rhapis excelsa* (8.7) against pest, diseases and other problems; *Scindapsus aureus* scored the highest (8.9) against general performance and *Anthurium andreanum* 'Bonina' (4.9) for APTI. In total, *Scindapsus aureus* was rated as the best among all the species which scored 35.8 out of 50 with regard to all the concerned characters and *Rhapis excelsa* the poorest with 30.8 points.

4.3.7. Atmospheric conditions

The maximum and minimum temperature, relative humidity and light intensity prevailed during the experimental period in different indoor zones were recorded and presented in Appendix 2.

4.3.8. Correlation studies

The plant characters of foliage plants were correlated with the light intensities provided in different zones so as to find out its influence on growth of foliage plants. However, the other conditions like temperature, RH in all zones were kept same except in the air conditioned zone.

Table 27. Quality rating of selected foliage plants under indoor conditions

S. No.	Plant species	Growth and Fullness (Out of 10)	Tolerance capacity (Out of 10)	Pest and Diseases & Other problems (Out of 10)	General performance (Out of 10)	APTI (Out of 10)	Total (Out of 50)	Ranks according to quality rating
1	*Anthurium andreanum* 'Bonina'	7.6	7.1	8.2	7.5	4.9	35.3	**2**
2	*Chrysalidocarpus lutescens*	7.5	7.4	7.0	8.7	3.9	34.5	**4**
3	*Ficus benjamina*	7.0	6.8	8.5	8.2	4.4	34.9	**3**
4	*Philodendron* 'Ceylon Gold'	6.6	6.9	8.2	7.2	2.6	31.5	**8**
5	*Philodendron elegans*	6.8	7.1	8.4	7.4	3.3	33.0	**7**
6	*Rhapis excelsa*	6.8	6.6	8.7	6.2	2.5	30.8	**10**
7	*Schefflera arboricola*	7.3	7.2	8.4	8.6	2.7	34.2	**5**
8	*Scindapsus aureus*	8.3	7.5	8.2	8.9	2.9	35.8	**1**
9	*Spathiphyllum wallisii*	8.4	7.4	6.3	8.6	2.4	33.1	**6**
10	*Syngonium podophyllum*	8.0	6.9	5.7	8.7	2.1	31.4	**9**

Table 28. Correlation between plant characters and light intensity in Low light intensity zone

S. No.	Plant species	Plant height	No. of leaves	Plant spread		Leaf area	Leaf length	Leaf breadth	Internodal length	Petiole length	Petiole girth
				NS	EW						
1	*Anthurium andreanum* 'Bonina'	-0.159	-0.734	-0.179	0.654	-	-	-	-	-	-
2	*Chrysalidocarpus lutescens*	0.335	-0.768	0.999*	0.997*	-	-	-	-	-	-
3	*Ficus benjamina*	-0.845	-0.838	0.845	0.845	-	-	-	-	-	-
4	*Philodendron* 'Ceylon Gold'	-0.153	0.159	0.790	0.780	-	-	-	-	-	-
5	*Philodendron elegans*	-0.960*	-0.832	0.606	0.948	-	-	-	-	-	-
6	*Rhapis excelsa*	0.188	0.091	0.807	0.492	-	-	-	-	-	-
7	*Schefflera arboricola*	-0.233	-0.843	0.740	0.964*	-	-	-	-	-	-
8	*Scindapsus aureus*	0.230	0.309	-0.416	-0.090	-0.921	-0.878	-0.878	-0.824	0.350	-0.878
9	*Spathiphyllum wallisii*	0.475	0.199	0.884*	0.736	-	-	-	-	-	-
10	*Syngonium podophyllum*	0.571	0.551	0.731	-0.152	-	-	-	-	-	-

*Significantly correlated at 5 % level

Table 29. Correlation between plant characters and light intensity in medium light intensity zone

S. No.	Plant species	Plant height	No. of leaves	Plant spread		Leaf area	Leaf length	Leaf breadth	Internodal length	Petiole length	Petiole girth
				NS	EW						
1	*Anthurium andreanum* 'Bonina'	0.314	0.308	-0.435	0.037	0.100	0.739	-0.327	-	0.995	0.545
2	*Chrysalidocarpus lutescens*	-0.345	-0.539	-0.070	-0.173	0.373	0.674	0.674	-	-0.241	0.662
3	*Ficus benjamina*	0.095	0.194	0.240	0.160	-0.943	-0.595	1.000*	0.320	-0.530	-0.937
4	*Philodendron* 'Ceylon Gold'	0.029	-0.579	0.003	0.139	0.777	0.586	0.826	-0.288	0.711	0.603
5	*Philodendron elegans*	0.012	0.478	0.488	0.066	-0.226	-0.623	-0.999*	-0.833	-0.987	0.434
6	*Rhapis excelsa*	0.540	-0.504	-0.217	0.280	-0.079	-0.045	-0.165	-	-0.984	0.999*
7	*Schefflera arboricola*	0.726*	0.511	0.130	-0.157	-0.517	0.916	-0.167	-0.416	-1.000*	1.000*
8	*Scindapsus aureus*	-0.660	0.120	0.099	-0.013	0.998*	0.920	0.978	0.450	-0.519	-0.165
9	*Spathiphyllum wallisii*	0.223	-0.575	-0.094	-0.293	-0.269	0.318	0.350	-	-0.154	0.986
10	*Syngonium podophyllum*	0.048	-0.030	0.463	0.105	-0.696	-0.745	-0.789	-0.580	-0.906	-0.595

*Significantly correlated at 5 % level

Table 30. Correlation between plant characters and light intensity in high light intensity zone

S. No.	Plant species	Plant height	No. of leaves	Plant spread		Leaf area	Leaf length	Leaf breadth	Internodal length	Petiole length	Petiole girth
				NS	EW						
1	*Anthurium andreanum* 'Bonina'	0.306	0.460	0.133	0.254	0.963	-0.999*	0.898	-	0.982	0.671
2	*Chrysalidocarpus lutescens*	0.005	-0.541	0.458	0.425	-0.980	-0.214	-0.214	-	0.019	0.842
3	*Ficus benjamina*	-0.149	0.389	0.224	0.155	0.717	-0.554	-0.999*	0.986	-0.211	-
4	*Philodendron* 'Ceylon Gold'	0.149	0.287	0.451	0.135	-0.017	-0.069	-0.731	-0.653	-0.699	-0.183
5	*Philodendron elegans*	0.273	0.291	0.424	0.325	-0.649	-0.555	0.084	0.715	0.022	-0.124
6	*Rhapis excelsa*	0.595	-0.512	0.213	0.362	-0.998*	-0.226	-0.069	-	0.563	-0.069
7	*Schefflera arboricola*	0.311	0.381	0.511	0.292	0.424	-0.678	-0.121	-0.444	-0.991	-0.830
8	*Scindapsus aureus*	-0.577	0.542	0.454	-0.103	0.941	0.990	0.999*	-0.126	0.439	0.991
9	*Spathiphyllum wallisii*	-0.115	-0.279	-0.013	0.403	0.238	-0.012	0.115	-	-0.269	0.642
10	*Syngonium podophyllum*	0.384	0.148	0.256	0.466	-0.151	-0.767	0.087	-0.989	-0.050	-0.270

*Significantly correlated at 5 % level

Table 31. Correlation between plant characters and light intensity in supplementary light intensity zone

S. No.	Plant species	Plant height	No. of leaves	Plant spread		Leaf area	Leaf length	Leaf breadth	Internodal length	Petiole length	Petiole girth
				NS	EW						
1	*Anthurium andreanum* 'Bonina'	0.520	0.649	0.742	0.701	-	-	-	-	-	-
2	*Chrysalidocarpus lutescens*	0.616	0.585	0.461	0.566	-	-	-	-	-	-
3	*Ficus benjamina*	0.650	0.867	0.468	0.469	-	-	-	-	-	-
4	*Philodendron* 'Ceylon Gold'	-0.114	-0.106	-0.177	-0.011	0.923	0.918	0.882	0.962	0.768	0.895
5	*Philodendron elegans*	-0.094	0.158	-0.034	-0.367	0.473	0.744	0.341	0.229	0.438	0.829
6	*Rhapis excelsa*	0.022	0.136	-0.251	-0.274	-0.096	0.876	0.829	-	0.837	0.708
7	*Schefflera arboricola*	-0.044	0.094	-0.096	-0.242	0.979	0.840	0.975	0.997*	0.818	0.692
8	*Scindapsus aureus*	0.247	-0.020	0.006	-0.340	0.898	0.889	0.748	0.848	0.805	0.881
9	*Spathiphyllum wallisii*	0.174	0.380	-0.373	0.032	0.972	0.901	0.940	-	0.873	0.692
10	*Syngonium podophyllum*	-0.476	-0.410	-0.246	-0.345	0.879	0.757	0.964	0.392	0.746	0.685

*Significantly correlated at 5 % level

Table 32. Correlation between plant characters and light intensity in air conditioned with supplementary light intensity zone

S. No.	Plant species	Plant height	No. of leaves	Plant spread		Leaf area	Leaf length	Leaf breadth	Internodal length	Petiole length	Petiole girth
				NS	EW						
1	*Anthurium andreanum* 'Bonina'	-0.572	0.388	0.426	-0.466	0.985	0.933	0.494	-	0.998*	-0.993
2	*Chrysalidocarpus lutescens*	0.180	-	-0.712	0.429	-0.932	-0.383	-0.383	-	0.451	-0.832
3	*Ficus benjamina*	-0.679*	0.384	0.029	0.208	-0.142	0.045	-0.311	0.708	-	-
4	*Philodendron* 'Ceylon Gold'	-0.211	-0.012	0.176	-0.734*	-0.952	-0.956	-0.893	-0.946	-0.944	-0.842
5	*Philodendron elegans*	-0.250	0.677*	-0.491	-0.655	0.776	0.690	-	-0.972	-0.985	-0.955
6	*Rhapis excelsa*	-0.417	-0.307	-0.922*	-0.823*	0.058	0.540	0.718	-	0.614	0.597
7	*Schefflera arboricola*	-0.631	0.350	0.144	-0.329	-0.388	-0.597	-0.597	-0.486	-0.762	0.827
8	*Scindapsus aureus*	-0.273	-0.630	-0.327	-0.475	-0.072	0.328	0.396	-0.173	-0.742	-0.435
9	*Spathiphyllum wallisii*	-0.341	0.007	-0.501	-0.080	-0.297	-0.522	-0.513	-	-0.597	-0.116
10	*Syngonium podophyllum*	-0.719*	-0.602	0.387	-0.393	0.959	0.964	0.991	-	0.823	-0.302

*Significantly correlated at 5 % level

4.3.8.1. Correlation of light intensity with indoor foliage plant characters

It was observed that the foliage plants kept under different light levels were significantly correlated with light intensity with regard to most of their characters like height, number of leaves, spread, leaf length and breadth, petiole length and girth and internodal length and presented in Tables 28-32.

The plant spreads of *Chrysalidocarpus lutescens* (both north- south and east-west), *Schefflera arboricola* (east-west) and *Spathiphyllum wallisii* (north-south) were positively correlated and plant height of *Philodendron elegans* was negatively correlated with low light intensity (<800 lux).

The leaf breadth of *Ficus benjamina*, plant height and petiole girth of *Schefflera arboricola*, petiole girth of *Rhapis excelsa* and leaf area of *Scindapsus aureus* were positively correlated with medium light intensity (800-2000 lux) whereas leaf breadth of *Philodendron elegans* and petiole length of *Schefflera arboricola* were negatively correlated.

The leaf breadth of *Scindapsus aureus* was correlated positively and leaf length of *Anthurium andreanum* 'Bonina', leaf breadth of *Ficus benjamina* and leaf area of *Rhapis excelsa* were negatively correlated with the high light intensity (>2000 lux).

The internodal length of *Schefflera arboricola* was positively correlated with the supplementary light provided (800-2000 lux).

In the air conditioned room with supplementary light (800-2000 lux) the petiole length of *Anthurium andreanum* 'Bonina' and number of leaves of *Philodendron elegans* were positively correlated whereas, the plant height of *Ficus benjamina* and *Syngonium podophyllum*, plant spread of *Philodendron* 'Ceylon Gold' (east-west) and *Rhapis excelsa* (both north-south and east-west) were negatively correlated.

4.4. Air borne microbial and dust filtering efficiency of indoor foliage plants

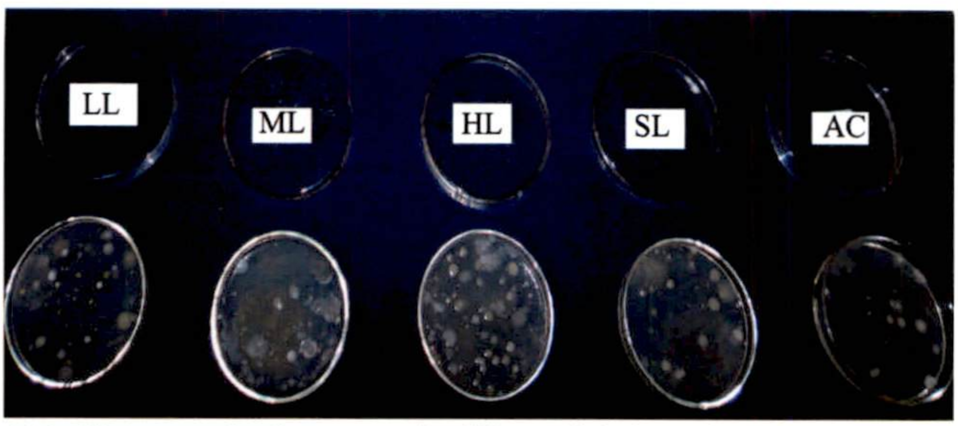
4.4.1. Air borne microbial filtering efficiency of indoor foliage plants

Data on the air borne microbial filtering efficiency of indoor plants is represented in Table 33. The experiment was conducted at different zones of light intensities with and without plants. A significant amount of reduction of air borne microbes was observed in the zones with plants. The maximum amount of reduction (35.43 %) was recorded in the zone with medium light intensity where the zone recorded 127 Total colony forming units (Tcfu) if kept plant free and 82 Tcfu when filled with plants. It was closely followed by the air conditioned zone with supplementary light which recorded 30.38 per cent reduction from 79

Plate 12. Air borne microbial filtering efficiency of foliage plants

12.1. PCA media filled petridishes being exposed at different zones

12.2. Petridishes after 48 hrs incubation period



12.3. Air borne microbes present in different light intensity zones

12.4. Air borne microbes present in medium light intensity zone

Tcfu to 55 Tcfu when the zone was filled with plants. The other zones of low, high and supplementary light recorded a reduction percentage of 14.85, 20, and 23.08 respectively. The interaction effect of different zones with the factors, *i.e.* presence or absence of plants produced no significant effects.

4.4.2. Dust filtering efficiency of indoor foliage plants

The amount of dust collected by different species is given in Table 34. Among the plants tested in the indoor conditions for evaluating the efficiency of dust filtering, there is no significant difference between the species. However, the maximum amount of dust (3.57 g/m^2) was collected by *Syngonium podophyllum* and it was closely followed by *Philodendron elegans* with 3.14 g/m^2 and the other species also collected considerable amount of dust. The least was *Scindapsus aureus* (0.51 g/m^2).

Table 33. Air borne microbial filtering efficiency of indoor plants under different growing conditions

S. No.	Test areas/growing conditions	Total colony forming units (Tcfu)	Reduction in microbial population (%)
I.	Low light intensity zone (<800 lux) a. With indoor plants b. Without plants	86 [b]101	14.85
II.	Medium light intensity zone (800-2000 lux) a. With indoor plants b. Without plants	82 [b]127	35.43
III.	High light intensity zone (>2000 lux) a. With indoor plants b. Without plants	108 [a]135	20.00
IV.	Zone with supplementary light (800-2000 lux) a. With indoor plants b. Without indoor plants	80 [b]104	23.08
V.	Zone with supplementary light + A/C (800-2000 lux) a. With indoor plants b. Without plants	55 [c]79	30.38
	Significance i. At different light intensities ii. With & without indoor plants iii. At different light intensities x with & without indoor plants	* ** NS	

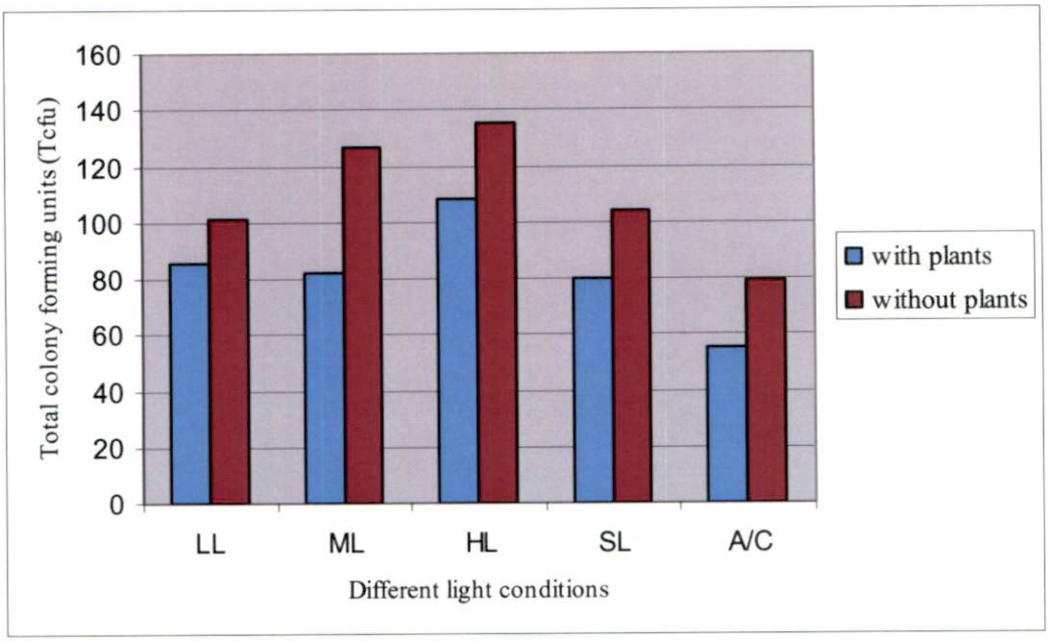
NS, *, ** =Not significant, significant at 5% level, and significant at 1% level respectively

Treatment means having similar alphabets in superscript, do not differ significantly

Table 34. Dust filtering efficiency of indoor plants under different growing conditions

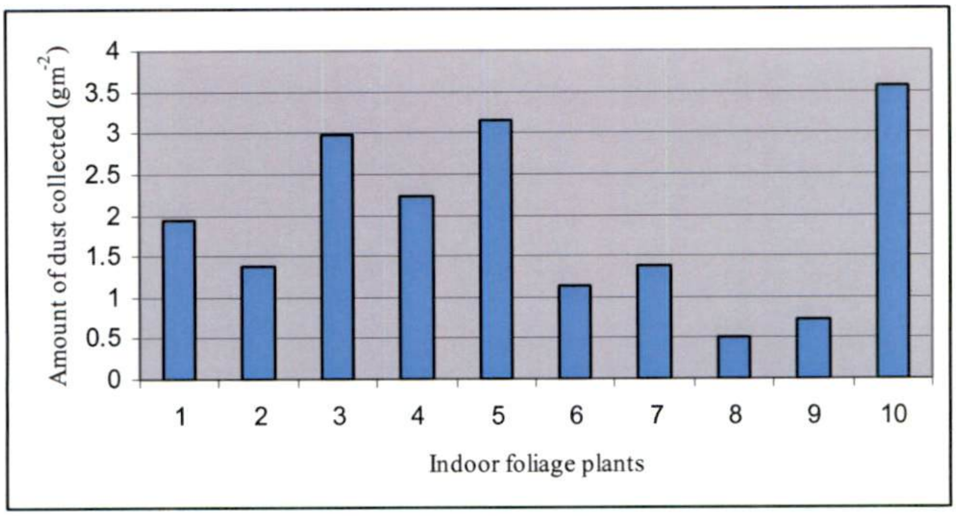
S. No.	Foliage plant species	Amount of dust collected (g/m^2)
1.	*Anthurium andreanum* 'Bonina'	1.95
2	*Chrysalidocarpus lutescens*	1.38
3.	*Ficus benjamina*	2.98
4.	*Philodendron* 'Ceylon Gold'	2.24
5.	*Philodendron elegans*	3.14
6.	*Rhapis excelsa*	1.15
7.	*Schefflera arboricola*	1.39
8.	*Scindapsus aureus*	0.51
9.	*Spathiphyllum wallisii*	0.72
10.	*Syngonium podophyllum*	3.57
	CD (0.05)	NS

NS=Not significant



LL-Low light (<800 lux), ML- Medium light (800-2000 lux), HL- High light (>2000 lux), SL- Supplementary light (800-2000 lux), A/C- Supplementary light with air condition (800-2000 lux)

Fig 24. Air borne microbial filtering efficiency of selected foliage plants under indoor conditions



1. *Anthurium andreanum* 'Bonina', 2. *Chrysalidocarpus lutescens*, 3. *Ficus benjamina*, 4. *Philodendron* 'Ceylon Gold', 5. *Philodendron elegans*, 6. *Rhapis excelsa*, 7. *Schefflera arboricola*, 8. *Scindapsus aureus*, 9. *Spathiphyllum wallisii*, 10. *Syngonium podophyllum*

Fig 25. Dust filtering efficiency of selected foliage plants under indoor conditions

Discussion

5. DISCUSSION

5.1. Performance of foliage plants under two growing systems

Different growth parameters like plant height, spread, number of leaves, leaf length and breadth, leaf area, internodal length, leaf producing interval, etc. of 50 plant species were observed in two growing systems, viz., open ventilated greenhouse (OV) and fan and pad greenhouse (FP)

5.1.1. Quantitative characters

When the height was concerned, growing systems had no significant influence in most of the plants throughout the year. However, the plants were comparatively taller in FP. The economic importance of plant height is manifested together with the number of branches and internodal length (Eapen, 2003). In the present study also, the tallest plants had more internodes and branches. The length of vines was taken as height for climbing and trailing plants and so they seem to possess more height than others. The findings of Aasha (1986) were also supporting the results. The plants with lesser height could be utilized for decorating places like small rooms and the space occupied by them is also minimum. The plants with more height will provide great appeal when used in places like indoor stadiums, big marriage halls etc.

Plant spread is an important character considering the foliages for interior plantscaping. The minimum is the spread, more compact will be the plants for indoors. The plants with maximum spread could also be desirable as it helps to decorate (cover) a large interior with few number of plants. The spread of climbing and trailing plants was not observed as they were subjected to frequent pruning. The species in other categories with more spread were *Tillandsia stricta*, *Chrysalidocarpus lutescens*, *Tacca chantrieri*, *Dieffenbachia amoena*, *Dracaena marginata* and *Cyperus alternifolius*. The plants with minimum spread were *Tradescantia spathacea* 'Sitara', *Polyscias guilfoylei*, *P. paniculata* 'Variegata', *Kalanchoe blossfeldiana*, *Anthurium andreanum* 'Bonina', *Zamioculcas zamiifolia* and *Chlorophytum* 'Charlotte'. The plants with more branches/laterals were found to have more spread and the plants with vertical growth rather than lateral growth were having lesser spread. Such differences in plant spread were also observed by Russ and Pertuit (2001) in different foliage plant species like *Dracaena, Philodendron and Schefflera.*

As we deal with foliage plants, it would be meaningless if we are not considering the leaf characters. Length, breadth, area and number of leaves are the main parameters that need to be observed to understand the variation among the foliage plants. As the plants possess attractive foliages, the number of leaves and its size will give great impact in decorating the indoors. Among the different categories, the species with the lengthiest leaves were *Tillandsia stricta, Chrysalidocarpus lutescens, Iris innominata, Nephrolepis exaltata, Cyperus alternifolius, Philodendron elegans* and *Philodendron* 'Ceylon Gold'. The species with the shortest leaves were *Begonia rex, Ficus benjamina, Kalanchoe blossfeldiana, Zamioculcas zamiifolia, Chlorophytum* 'Charlotte' and *Scindapsus aureus*. Among the growing systems, in OV, rosette, tree-like and upright types had the lengthiest leaves, whereas in flowering and grass-like plants the lengthiest leaves were in FP and in climbing and trailing type, the lengthier leaves were produced in both systems. The same pattern of leaf length was also observed by Eapen (2003) in different foliage plants where *Nephrolepis exaltata* had the maximum length. Again in breadth, the species which recorded the broadest leaves were *Anthurium crystallinum*, *Chrysalidocarpus lutescens*, *Tacca chantrieri*, *Anthurium andreanum* 'Bonina', *Dieffenbachia amoena*, *Cyperus alternifolius* and *Philodendron elegans* in their corresponding categories. *Tillandsia stricta*, *Codiaeum variegatum* 'Punctatum aureum', *Iris innominata*, *Pleomele reflexa*, *Scirpus cernuus* and *Syngonium wendlandii* were the plants with the narrowest leaves in different groups. In comparison with the growing systems, in OV plants had broader leaves than in FP. Such wide variations in the length and breadth would provide a lot of choice for selecting plants for indoors. Such variations in leaves were also reported by Henny *et al.* (1987) and Henny (1995).

The factor which decides crop productivity is the leaf area, because the light incidence/interception depends on the size of leaf. So it has to be considered as a very important character. In the present study, the species with the maximum leaf area were *Anthurium crystallinum, Chrysalidocarpus lutescens, Licuala grandis, Tacca chantrieri, Anthurium andreanum* 'Bonina', *Dieffenbachia amoena, Cyperus alternifolius* and *Philodendron elegans*. The species with the minimum leaf area were *Rhoeo discolor, Tillandsia stricta, Tradescantia spathacea* 'Sitara', *Kalanchoe blossfeldiana, Zamioculcas zamiifolia, Scirpus cernuus* and *Syngonium wendlandii* among the different category of foliage plants. The plants having more leaf area will have a faster growth and there will be more crop productivity (Benedetto *et al.*, 2006). Wang and Chen (2003) also described about the importance of leaf area from the study conducted in *Spathiphyllum* in which they observed more CO_2 fixation in leaves having more area.

Another important leaf character is the number of leaves. More the number of leaves in a plant, more will be the physiological activities and so will be the benefits for the plant. It differs from species to species and depends on many factors like tiller production and leaf production intervals (Eapen, 2003). In the present study also it differed significantly between the species. Among the categories of foliage plants, the species with more leaves were *Tradescantia spathacea* 'Sitara', *Tillandsia stricta, Codiaeum variegatum* 'Punctatum aureum', *Ficus benjamina, Kalachoe blossfeldiana, Dracaena* 'Purple Compacta', *Pleomele reflexa, Scirpus cernuus* and *Scindapsus aureus* and *Syngonium podophyllum*. The species with lesser numbers were *Anthurium crystallinum, Chrysalidocarpus lutescens, Licuala grandis, Rhapis excelsa, Anthurium andreanum* 'Bonina', *Alpinia zerumbet* 'Variegata', *Dieffenbachia amoena, Sansevieria trifasciata* 'Laurentii', *Cyperus alternifolius* and *Philodendron elegans*. Basically the species with larger leaves tends to produce only less number of leaves whereas the species with smaller leaves have more number. This is because of many factors like genetic makeup, partition of photosynthates, production of more number of branches and tillers etc. So both the cases are desirable as they compensate each other with their size and number of leaves.

When the internodal length of foliage plants was concerned, most of the species had no internodes due to rosette arrangement of leaves as they were short and compact which are the desirable qualities needed for interior plantscaping. However, the internodal length is important because of its contribution to plant height. If a plant could withstand low light conditions, it can be well identified by its long internodes. In the present study, the plants which had the maximum internodal length were *Begonia rex, Ficus banjamina, Kalanchoe blossfeldiana, Alpinia zerumbet* 'Variegata' and *Philodendron elegans*. The species with minimum length of internodes were *Tradescantia spathacea* 'Sitara', *Codiaeum variegatum* 'Punctatum aureum', *Chrysothemis pulchella, Dracaena sanderiana, Pleomele reflexa* and *Philodendron* 'Ceylon Gold' among various categories of foliage plants. All grass-like plants had no internodes. FP was found to be good to have more internodal length in plants of rosette, tree-like and flowering types. But in upright and climbing and trailing types, OV was good because of the incidence of more light.

Length and girth of petiole are important for the physical support they render to the leaves. Also the length of the leaf contributes to spread of the plant. More the petiole length, more will be the spread and higher the compactness, if it is short. The plants with lengthiest petioles were *Anthurium crystallinum, Chrysalidocarpus lutescens, Anthurium andreanum*

'Bonina', *Nephrolepis exaltata, Cyperus alternifolius and Philodendron elegans. Begonia rex, Ficus benjamina, Chrysothemis pulchella, Costus curvibracteatus, Peperomia clusiifolia, Zamioculcas zamiifolia, Chlorophytum* 'Charlotte' and *Asparagus setaceus* were the plants with shortest petiole. The plants kept in OV were found to produce long petioles in rosette, upright and climbing and trailing types whereas in tree-like and flowering plants, it was the reverse. In grass-like plants, there was no significant difference between the systems. Likewise, the species with thickest petiole were *Philodendron wendlandii, Chrysalidocarpus lutescens, Tacca chantrieri, Dieffenbachia amoena* and *Philodendron elegans*; the species with thinnest petiole were *Begonia rex, Ficus benjamina, Anthurium andreanum* 'Bonina', *Nephrolepis exaltata, Peperomia obtusifolia* 'Sensation' and *Asparagus setaceus.* Among the growing systems, plants in FP had the thickest petiole. As like internodal length, petiole length is also linked with the capability of plant to withstand low light conditions. In general, mostly the petiole length and girth was according to the size of the leaves. The succulent types were having slender and weaker petioles.

Regarding the leaf producing interval, it varies according to the species. The species which produced leaves at shorter intervals were *Rhoeo discolor, Codiaeum variegatum* 'Punctatum aureum', *Kalanchoe blossfeldiana, Pleomele reflexa, Scindapsus aureus* and *Syngonium podophyllum.* The plants producing leaves at longer intervals were *Anthurium crystallinum, Chrysalidocarpus lutescens, Anthurium andreanum* 'Bonina', *Sansevieria trifasciata* 'Hahnii', *Sansevieria trifasciata* 'Laurentii' and *Philodendron* 'Ceylon Gold'. It is found that the plants with shorter leaf producing intervals were having high growth rate and they can establish themselves easily within a short period of time, whereas plants with long leaf producing interval will take longer time to establish. There was no significant difference between the growing systems in leaf producing intervals.

The leaf longevity on the plant is linked with the leaf producing intervals. If a plant produces leaves at longer intervals, longevity of the leaf is found to be more. In the present study, the species with higher leaf longevity were *Tillandsia stricta, Rhapis excelsa, Spathiphyllum wallisii, Sansevieria trifasciata* 'Hahnii', *S.trifasciata* 'Laurentii', *Ophiopogon jaburan, O.jaburan* 'Variegata' and *Scindapsus aureus. Begonia rex, Ficus benjamina, Chrysothemis pulchella, Dracaena* 'Purple Compacta', *Chlorophytum* 'Charlotte' and *Syngonium wendlandii* were the species that had low leaf longevity among the different categories.

5.1.2. Qualitative characters

Texture, type, shape, margin, tip, base, pigmentation, venation and arrangement of leaves, branching habit, pest and diseases and other damaging symptoms were taken as qualitative characters as they helped to relate with the aesthetic value of the plants. The plants like *Aglaonema nitidum* 'Curtisii', *A. pseudobracteatum*, *Dieffenbachia amoena* and *Dracaena sanderiana* need proper staking as they tend to bend. It is recommended that besides staking regular pruning or trimming is necessary for plants like *Begonia rex*, *Nephrolepis exaltata*, *Asparagus setaceus*, *Philodendron* 'Ceylon Gold', *Philodendron elegans*, *Scindapsus aureus*, *Syngonium podophyllum*, *Schefflera arboricola* and *Syngonium wendlandii* to maintain their stature.

The plants were also rated according to their quality characters like colour and texture, pigmentation, tolerance-capacity (to indoor low light conditions), pests and disease occurrence. The species rated high among different categories of foliage plants were *Anthurium crystallinum*, *Chrysalidocarpus lutescens*, *Anthurium andreanum* 'Bonina', *Sansevieria trifasciata* 'Laurentii', *Ophiopogon jaburan* 'Variegata' and *Scindapsus aureus*. Those plants can be well recommended as best foliage plants which possess all the qualities to be grown in any type of growing systems and they can be well suited for testing under indoor conditions. This kind of visual quality grading was also done by Wang *et al.* (2005).

Regarding pest and disease attack, it was almost similar in both the systems with snails in most of the plants, diseases like stem rot in *Aglaonema nitidum* 'Curtisii', leaf spot in *Tacca chantrieri* etc as already described by Knauss *et al.* (1981) and Hamlen *et al.* (1981). The reason behind the infestations in fan and pad greenhouse was the high humidity which favoured most of the diseases and in open ventilated greenhouse, it was not protected with insect proof nets.

Qualitative flower characters like type, colour, appearance and fragrance were also recorded as the foliage plants with flowers were considered as having some additional value.

5.2. Weather parameters and their correlation with plant characters

Weather parameters were recorded and they were correlated with the plant characters. From the correlations obtained, it is clear that the plants in different growing systems were significantly influenced by the weather conditions.

As the present study dealt with fifty different species, deriving specific figure about a single species is difficult but as a whole, fan and pad greenhouse was found more suitable when the quality attributes were compared with the plants in open ventilated greenhouse.

The maximum and minimum temperature prevailed in both systems were found positively correlated only with number of leaves of *Ficus benjamina*. All the remaining characters were negatively correlated which showed that increase in temperature could be deleterious to the foliage plants. It is confirmed with the range of temperature already recommended by Manaker (1997), who suggested that temperatures above 32 to 35°C may be detrimental to plant cells, causing photosynthesis to decline and this may be the reason for most of the negative correlations. He also suggested there is no specific temperature at which all plants grow best, but rather an optimal range of temperatures for each plant species. For most tropical foliage plants, a temperature range of 18 to 24°C is satisfactory. Buck and Blessington, (1982) pointed out that high temperature may be harmful to plants by causing excessive transpiration, which results in wilting and desiccation of tissues. Respiration will increases causing a depletion of stored food. Death of the entire plant may result from too-high temperatures. With rapid warming, coagulation of proteins occur, thereby disrupting protoplasmic structure. When the warming is more gradual, proteins are broken down, releasing ammonia, which is toxic.

Relative humidity is important because it affects transpiration, and hence the plant-water relationships. Although most tropical foliage plants thrive at humidities greater than 30%, they will survive in the low-moisture environments prevalent inside the building if they are properly acclimatized (Manaker, 1997). The positive correlation among plant characters with regard to RH was also very few in both the systems which shows that the foliages need a medium range of RH. The higher level of RH will enhance the deleterious effects by inviting more pests and diseases.

Unlike maximum and minimum temperatures and RH, the plants showed greater response to the light intensity which was obvious from the positive correlations obtained in many characters like plant height, number of leaves etc. So it may be concluded that the light conditions of both the systems were good for growing foliage plants which supports the findings of Geetha *et al.* (2002) where they found that the foliage plants were grown better under 50 per cent shade.

In general, the present study revealed that the growing system with fan and pad ventilation was superior to the system with natural ventilation for most of the parameters observed. The reason may be that the forced ventilation reduces inside temperature during sunny days and supplies carbon dioxide which is vital for photosynthesis. Another advantage of this ventilation is to remove warm, moist air and replace it with dry air. Again, the pad and misting provided for evaporative cooling can prevent/protect the plants from heat build up inside the polyhouse (Worley, 2011). But during rainy season, high humidity was observed in the system which is not desirable since it causes moisture condensation on cool surfaces and increases the occurrence of pests and diseases.

In some cases, the natural ventilation was observed to have some favourable influence on growth parameters. The study conducted by Kumar *et al.* (2009) also showed that the fan and pad system is the most suitable in areas of low humidity of the tropics and subtropics as they observed that the inside air temperature was lowered to 4-6°C if used alone and 4-12 °C if used along with shading. So we can also conclude that system with fan and pad ventilation is good for production of foliage plants provided humidity levels are maintained at optimum. It also indicates that under current scenario of changing climate where high night temperature is a detrimental factor declining plant growth and development, the fan and pad system is a good option for growing foliage plants.

5.2. Air pollution tolerance index of foliage plants

Polluted atmosphere is one of the major challenges that man has to face today for his existence. In some circumstances, poor indoor air quality may pose serious health risks, particularly in susceptible individuals. Plants are our resource and weapon to fight against this. The air pollution tolerance index of plants can be used to monitor the quality of air. As suggested by Singh *et al.* (1991), APTI can be calculated by estimating four parameters *viz.*, total chlorophyll content, leaf extract pH, relative water content and ascorbic acid content. The index was developed based on the fact that ascorbic acid being a strong reductant, protects chlorophyll functions from pollutants through its pH dependent reducing power (Tanaka *et al.*, 1982) and RWC shows the capacity of cell membrane to maintain its permeability under polluted conditions (Singh *et al.*, 1991).

As far as foliage plants are concerned in the present study, the parameters were determined carefully in different seasons and their susceptibility/tolerance to air pollution was also assessed accordingly and the results obtained are discussed here.

5.2.1. Total chlorophyll content

Among the different parameters that determine the tolerance level of plants to pollution, chlorophyll content plays an important role as it indicates the photosynthetic activity as well as the growth and development of biomass (Bell and Mudd, 1976; Jyothi and Jaya, 2010). Tolerance of plants to SO_2 is reported to be linked with synthesis or degradation of chlorophyll (Bell and Mudd, 1976; Ninave *et al.*, 2001). Thus, plants having high chlorophyll content are generally found tolerant to air pollutants (Singh *et al.*, 1991). Further the total chlorophyll content is also related to ascorbic acid productivity (Aberg, 1958) which is having a strong reductant action against the pollutants and ascorbic acid is concentrated mainly in chloroplast (Franke and Heber, 1964). In the present study variations were observed in the chlorophyll content of plants which also varied with seasons. *Asparagus setaceus* was having the highest chlorophyll content during March-April, whereas during June-July, it was in *Dracaena marginata*, *Scirpus cernuus* and *Syngonium wendlandii.* During October-November, the maximum content was in *Dracaena marginata.* As such, the lowest chlorophyll content was estimated in *Scindapsus aureus* during March-April and *Peperomia clusiifolia* during June-July and October-November. The total chlorophyll content of the foliage plants was evidently influenced by prevailing light conditions during the seasons and also variegation of leaves. Plants with dark green leaves have more chlorophyll content compared to plants with variegated leaves (Wood and Burchett, 1995).

5.2.2. Leaf extract pH

Leaf pH is the determining factor for most of the biochemical reactions in leaf. Moreover, photosynthetic efficiency strongly depends on this factor (Liu and Ding, 2008). Türk and Wirth (1975) reported that photosynthetic efficiency was found to be low in plants when the leaf pH was low. It has been reported that, in the presence of an acidic pollutant, the leaf pH is lowered and the decline is greater in plants which are sensitive to pollution compared to tolerant ones (Scholz and Reck, 1977). Thus, a higher level of leaf-extract pH in plants under polluted conditions may increase their tolerance level (Singh *et al.*, 1991). Further, the presence of an acidic pollutant may turn the cell sap acidic and decrease the efficiency of conversion of hexose sugar to ascorbic acid. However, the reducing activity of ascorbic acid is pH dependent being more at higher and less at lower pH (Jothi and Jaya, 2010). In the present study, tree like foliage plants possessed more pH than succulents. During March-April and October-November, the maximum pH content was in *Ficus benjamina*, whereas in June-July it was in *Scindapsus aureus*. The lowest leaf extract pH was in *Anthurium crystallinum* during March-April and June-July, while *Sansevieria trifasciata* 'Laurentii' recorded the lowest pH during October-November.

5.2.3. Relative Water Content (RWC)

The RWC of leaves is an indicator of plant water status in relation to its physiological activities of cell water and it ranged from 100.25 to 69.79 per cent between different species in different seasons. It is associated with protoplasmic permeability (Oleinikova, 1969) and the air pollutants increase cell permeability (Keller, 1986) in the case of sensitive species (Farooq and Beg, 1980). Pollutant induced increased permeability in cells causes loss of water and dissolved nutrients, resulting in early senescence of leaves (Masuch *et al.*, 1988). Therefore it is likely that plants with high RWC under polluted conditions may be tolerant to pollutants (Singh *et al.*, 1991). More water content will also dilute acidity. Further, high water content within a plant body will help to maintain its physiological balance under stress condition such as exposure to air pollution when the transpiration rates are usually high, and also serves as an indicator of drought tolerance in plants (Swami *et al.*, 2004; Dedio, 1975). If transpiration rate is reduced due to air pollution, plants cannot sustain due to loss of capacity to pull water up with roots for photosynthesis. Then, the plants neither bring minerals from the roots to leaves where biosynthesis occurs, nor reduce the leaf temperature (Liu and Ding, 2008). Present investigation shows that *Sansevieria trifasciata* 'Laurentii' and *Tillandsia stricta* possessed maximum and minimum RWC during March-April respectively. During June-July, the maximum RWC was found in *Sansevieria trifasciata* 'Hahnii' while *Calathea ornata* 'Roseo-lineata' had the lowest and during October-November, it was *Peperomia obtusifolia* 'Sensation' that had the highest and the lowest was in *Cyperus alternifolius*. RWC was consistent over all the species with the exception of *Peperomia obtusifolia* 'Sensation' with 100.25 per cent during October-November. This could be the result of loss from damaged cells around the cut edges of the mesophyll when leaf discs were excised (Wood and Burchett, 1995).

5.2.4. Ascorbic acid

Ascorbic acid content of plants is considered to be more important than any other parameter to determine the susceptibility level. Though a plant possesses relatively low pH, chlorophyll content, and RWC, there is a great chance for the plant to have a higher APTI as the low values can be counter-balanced by the ascorbic acid multiplier effect in the APTI formula (Wood and Burchett, 1995). Moreover, studies showed that ascorbic acid is a strong reductant and a higher content favours pollution tolerance in plants (Keller and Schwager, 1977; Lee *et al.*, 1984). The level of this acid declines on exposure to pollutants. Thus, plants maintaining high ascorbic acid level even under polluted conditions are considered to be tolerant to air pollutants (Singh *et al.*, 1991). Conklin (2001) reported that ascorbic acid plays a vital role in cell wall synthesis, defense and cell division. Chaudhary and Rao (1977) and Varshney and Varshney (1984) are of the opinion that higher ascorbic acid content in plants is a sign of its tolerance against sulphur dioxide pollution. Tripathi and Gautam (2007) also reported that the increase in the concentration of ascorbic acid in the leaves of *Mangifera indica* near roadsides is due to enhanced pollution from automobiles. In the present study, *Anthurium andreanum* is found to contain more ascorbic acid during March-April and October-November and having the highest APTI value also. During June-July, the highest content was found in *Anthurium crystallinum* while *Syngonium podophyllum* scored the lowest during both June-July and October-November. During March-April, *Kalanchoe blossfeldiana* was found to possess the lowest ascorbic acid content and the APTI value was also the lowest.

5.2.5. APTI and susceptibility levels

The APTI values were computed for each species using the above four parameters. During March-April and October-November, *Anthurium andreanum* had the highest APTI and during June-July, it was in *Calathea zebrina. Syngonium podophyllum* had the lowest values of all species irrespective of seasons. It is evident that, no species had the maximum value for all the four parameters and each parameter plays a distinctive role in the determination of susceptibility of plants.

Different plant species showed considerable variation in their susceptibility to air pollution and it varied with the season. The plants with high APTI value could be identified as tolerant and, low as sensitive to pollution. A species which is tolerant during a season was not the same during the next season.

Though different parameters were taken, wide variation was seen only in ascorbic acid and it increased its impact by its multiplier effect in the APTI formula. Studies reveal that ascorbic acid through its reducing power protects chloroplasts against SO_2-induced H_2O_2, O_2- and OH accumulation, and thus protects the enzyme of the CO_2 fixation cycle and chlorophyll from inactivation (Tanaka *et al.*, 1982). Together with leaf pH, APTI plays a significant role in determining the SO_2-sensitivity of plants (Chaudhary and Rao, 1977). Its reducing power is more at higher and lower at low pH values. Thus, it may be possible that ascorbic acid protects chloroplasts and chlorophyll functions from pollutants through its pH-dependent reducing power. RWC, one of the parameters to compute APTI shows the capacity of the cell membrane to maintain its penneability under polluted condition. Thus, the combination of four parameters is suggested as representing the best index of the susceptibility levels of plants under any condition.

5.3. Evaluation under indoor conditions

Based on the pollution tolerance efficiency, ten foliage plants were selected for indoor studies under five different light levels, viz., low (<800 lux), medium (800-2000 lux), high (>2000 lux), supplementary (800-2000 lux) and air conditioned with supplementary light (800-2000 lux). Observations relevant to indoor conditions and the results are discussed here.

5.3.1. *Anthurium andreanum* 'Bonina'

Anthurium andreanum 'Bonina' was the most attractive foliage as well as flowering plant included in the study for which the APTI value was also high. The maximum longevity for this plant (70 days) was observed in the air conditioned zone with supplementary light without any symptoms of damage and in that condition, petiole length was positively correlated with light intensity. In high light zone, leaf length was positively correlated. The same kind of changes in canopy configuration with regard to light intensity was observed by Chen *et al.* (2005). The plant spread (east-west) was considerably good in medium, high and air conditioned zone with supplementary light. Even though it had high APTI value, the tolerance level was slightly low. The reason behind such a performance may be that Anthurium is sensitive to high light intensity, temperature and aeration (Gayathri, 2008) and the conditions were not quite suitable under indoor conditions provided except under the air conditioned zone with supplementary light. So Anthurium can well be recommended for indoor air conditioned conditions possessing medium light.

5.3.2. *Chrysalidocarpus lutescens*

Chrysalidocarpus lutescens, an elegant palm species is reported to perform good under indoor conditions (Trinklein, 1999). As such, it performed well in all light levels. Plant height, plant spread, leaf area, leaf length and breadth, petiole length and girth were recorded the highest mostly in all light levels at least during the first two fortnights. But its longevity in different light levels was not quite well except in medium and high light level zones where it could be kept for a maximum period of 70 days. It occupied fourth position in quality rating. The plant spread in both directions was correlated positively to the light intensity prevailed in low light level zone. As most palms need bright natural light year-round, longevity in low light levels was low as already reported by Davison (1998) and Russ (1999).

5.3.3. *Ficus benjamina*

Weeping fig, having more leaves was reported to be beneficial under indoor conditions by reducing the effects of dust, noise and microbes (Shaughnessy, 1999). The plant is recommended for high and medium light conditions (Haynes, 2006; Davison, 1998). The present results revealed that even though it is observed to have more leaf drop, it could retain more number of leaves compared to other species under study in all the light levels. This result confirmed with the findings of Steinkamp *et al.* (1991) and Bulle and deJongh, (2001). They also mentioned that leaf drop was the most important problem in *Ficus benjamina*. In medium light zone it could be kept for 70 days without any symptom whereas in high light zone, within 7 days it started to drop its leaves. In quality rating, it came third with average points. In medium light zone, leaf breadth was positively correlated with light intensity. In high light zone, it was negatively correlated and in air conditioned zone with supplementary light, plant height was negatively correlated. So medium light condition is very much suitable for *Ficus* which also exhibited more or less a medium tolerance to air pollution.

5.3.4. *Philodendron* 'Ceylon Gold'

Because of the tolerance to low light (Haynes, 2006) Philodendrons are preferred as indoor plants and most of them are well adapted to home growing (Davison, 1998; Trinklein, 1999).

Philodendron 'Ceylon Gold' is one of the finest species and its yellowish green leaves are very attractive and suitable for indoors. The performance was average compared to other species. It lasted for a longer period in medium and high light level zones. In quality rating, it ranked eighth. The plant spread (east-west) in the air conditioned zone with supplementary light was negatively correlated with light intensity.

5.3.5. *Philodendron elegans*

Even though it showed a slow growth in the initial stage, it picked up very fast and had the highest values in later stages as to show its adaptation to indoor conditions. Height and spread of plants were good in all light levels but reached the highest in high, supplementary light and air conditioned zone with supplementary light. The main phenomenon observed in this species was that the leaf area was the highest in low light zone. The same kind of increasing in leaf area in low light condition was observed by Chen *et al.* (2005) in *Ficus*. In the air conditioned zone with supplementary light, number of leaves was positively correlated with light intensity and in low and medium light zones, plant height and leaf breadth were negatively correlated with light intensity. It ranked seventh in quality rating among the ten species and could be retained for 70 days in all light zones except low where it could be kept only for 20 days.

5.3.6. *Rhapis excelsa*

Most of the palms are best suited to medium light conditions. Bright light may cause fading in some species and few are most tolerant to low light conditions (Trinklein, 1999). The main feature to be noticed in *Rhapis excelsa* is the plant spread. In all light levels it was the highest up to the third fortnight. But during the last fortnight, it was high only in medium and high light zones. Likewise, it had the highest leaf area irrespective of all light levels. In medium light zone, petiole girth was positively correlated with light and in high light and AC zone, leaf area and plant spread were negatively correlated. Regarding longevity, it was only three weeks in all light zones except in medium and high where it lasted longer. Even though it scored the highest against pests and disease attack, in quality rating, the rank was the lowest while considering the growth rate, tolerance capacity to light at later stages and general performance.

5.3.7. *Schefflera arboricola*

This plant prefers bright light (Shaughnessy, 1999) but tolerates medium light (Haynes, 2006) or even low light for limited periods (Trinklein, 1999). It will drop foliage in extended periods of poor light. It performed well in most of the light levels initially and in all light levels except low during the later stages. Leaf area was also the maximum except in the zone with supplementary light. Even though it had the shortest internodes of all, in supplementary light zone it was positively correlated with light which showed the response of

Plate 13. Foliage plants in indoor conditions after one month

13.1. *Anthurium andreanum* 'Bonina'

13.2. *Chrysalidocarpus lutescens*

13.3. *Ficus benjamina*

13.4. *Philodendron* 'Ceylon Gold'

13.5. *Philodendron elegans*

(In all pictures the pots are arranged in the order LL, ML, HL, SL & A/C from left to right respectively)

Plate 13. Foliage plants in indoor conditions after one month (Contd.,)

13.6. *Rhapis excelsa*

13.7. *Schefflera arboricola*

13. 8. *Scindapsus aureus*

13.9. *Spathiphyllum wallisii*

13.10. *Syngonium podophyllum*

Note:

(In all pictures the pots are arranged in the order LL, ML, HL, SL & A/C from left to right respectively) the plants towards light. In low light zone, plant spread was positively correlated with light intensity and in medium light zone, petiole length and girth were negatively and positively correlated respectively. In medium light zone, it lasted for maximum days without showing any symptom of damage. It occupied fifth position in quality rating.

5.3.8. *Scindapsus aureus*

It proved as the best foliage species among the plants evaluated under indoor conditions in this study. It performed well in all light levels as already reported by Davison (1998). It possesses variegation in leaves which adds more beauty to the indoors. Plant height, number of leaves and plant spread were maximum at later stages may be due to its ability for adaptation to the indoor conditions. Internodal elongation was also profuse as already stated by Chen *et al.* (2005). In quality rating, it scored maximum points in general performance and capacity to tolerate low light. Leaf area and leaf breadth were positively correlated with light in medium and high light zones respectively. As it belongs to climbing/trailing type, it easily adapts itself, adjusting plant height by increasing internodes and spreading towards light.

5.3.9. *Spathiphyllum wallisii*

In addition to its pretty foliage and flowers, the plant possesses flowers with a pleasant fragrance (a good alternative to costly room freshners). It was reported that to perform well in medium light (Shaughnessy, 1999) as well as in low light (Haynes, 2006). Regarding the plant characters it was observed that during the later stages viz., third and fourth fortnights, plant height, plant spread, leaf area and petiole girth were observed to be the maximum in all light levels except low. It was the one which produced the symptoms of damage very soon under indoor conditions in all light zones. In quality rating, it scored maximum points in growth and fullness. Plant spread (north-south) was positively correlated with light intensity in low light zone. So this species is sensitive to shade.

5.3.10. *Syngonium podophyllum*

A climbing and trailing type plant suitable to place near staircase, windowsill and other indoor spaces for its fast growing and easy adaptation to the conditions. Because of its leaf variegations, it will make the place so pleasant and beautiful and it is recommended for the places with medium light (Davison, 1998). The present study also revealed that it was the best plant suitable for medium light conditions either by getting light naturally by placing near window or artificially by providing supplementary lights. Internodal elongation was found more in this species, so to adapt itself to low light condition (Chen *et al.*, 2005) under which to intercept maximum light. Longevity of plants was more in zones of supplementary light and also in air conditioned zone. Plant height was negatively correlated with light intensity in air conditioned zone with supplementary light.

5.3.11. Pests, diseases and other deteriorating symptoms observed

The common pests observed under indoor conditions were leaf eating caterpillar and mealy bug supporting the finding of Caron (2004), Doubrava and Scott (2005) and Scott (2007) in *Chrysalidocarpus lutescens* and *Syngonium podophyllum.* All other plants were free of pests and diseases. The major symptoms which caused the plants unfit for indoors observed were tip brown, yellowing, drying of leaves, yellowish midrib, yellowish margin, leaf drop, bud drop, bending, wilting, lesion spots, elongated internodes, tenderness of leaves etc as already observed earlier by Kluepfel (2000) and Buss *et al.* (2007).

5.4. Air borne microbes and dust filtering efficiency of indoor foliage plants

5.4.1. Air borne microbes filtering efficiency of indoor foliage plants

There is a considerable amount of reduction of airborne microbes in a place with plants irrespective of the light conditions prevalent there. This result is supported by the findings of Wolverton and Wolverton (1996). They found that the airborne microbial level in a room without plants was more than fifty percent higher when compared to a room with plants. Reason for this reduction may be emission of compounds such as terpenes and various kinds and amounts of phenolic compounds that may be allelochemicals (Weaver and Klarich, 1977) which protect them from harmful microbes (Rice, 1979; Whittaker and Feeney, 1971). Though plants increased the humidity levels where microbes thrive well, they did it by transpiring mineral-free moisture that appears to contain substances suppressing the growth of airborne microbes.

5.4.2. Dust filtering efficiency of indoor foliage plants

Foliage plants were found to filter indoor air by collecting considerable amount of dust. Based on the amount of dust collected by the species, they could be arranged as *Syngonium podophyllum* > *Philodendron elegans* > *Ficus benjamina* > *Philodendron* 'Ceylon Gold'> *Anthurium andreanum* > *Schefflera arboricola* > *Chrysalidocarpus lutescens* >

Rhapis excelsa > *Spathiphyllum wallisii* > *Scindapsus aureus*. This substantiated the studies conducted by Varshney and Mitra (1993), Nainhuis and Barthlott (1998) and Kulshreshtha *et al.* (2009) under outdoor conditions in which they found that the dust filtering ability of the plant species was directly correlated with foliar surface characteristics-geometry, phyllotaxy, epidermal and cuticular features, leaf pubescence and height of the canopy.

Lohr and Pearson-Mims (1996) also proved that twenty per cent of accumulated particulate matter on horizontal surfaces in interiors was reduced by keeping foliage plants indoors.

Conclusion:

- The growing system with fan and pad was found better for growing foliage ornamental plants.
- List of plants found suitable for interior plantscaping are:
  - Rosette: *Anthurium crystallinum, Calathea zebrina, Philodendron wendlandii* and *Homalomena wallisii*
  - Tree-like: *Chrysalidocarpus lutescens, Codiaeum variegatum* 'Punctatum aureum', *Ficus benjamina, Licuala grandis, Rhapis excelsa* and *Schefflera arboricola*
  - Flowering: *Anthurium andreanum* 'Bonina', *Spathiphyllum wallisii* and *Kalanchoe blossfeldiana*
  - Upright: *Aglaonema pseudobracteatum, Dieffenbachia amoena, Sansevieria trifasciata* 'Laurentii', *Dracaena* 'Purple Compacta', *Peperomia obtusifolia* 'Sensation' and *Zamioculcas zamiifolia*
  - Grass-like: *Ophiopogon jaburan* 'Variegata', *Cyperus alternifolius* and *Chlorophytum* 'Charlotte'
  - Climbing and trailing: *Scindapsus aureus, Syngonium podophyllum, Philodendron* 'Ceylon Gold' and *Philodendron elegans.*
- Regarding APTI, *Anthurium andreanum* 'Bonina', *Calathea zebrina* and *Dracaena* 'Purple Compacta' were found more tolerant to air pollution irrespective of the seasons. In all the seasons, *Aglaonema pseudobracteatum, Kalanchoe blossfeldiana, Sansevieria trifasciata* 'Hahnii', *Spathiphyllum wallisii, Syngonium podophyllum, Tradescantia spathacea* 'Sitara' and *Zamioculcas zamiifolia* were found to be the most susceptible to pollution and they could be recommended as indicators for air pollution.

- Medium light condition (800-2000 lux) was found to be the best for growing/keeping foliage plants under indoor conditions.
- Indoor plants helped to reduce the level of air borne microbes up to 35 per cent.
- The foliage plants could filter the dust from indoor atmosphere up to 3.57 g/sq. m of the canopy.

Summary and Conclusion

6. SUMMARY

The present investigation on "Evaluation of foliage plants for interior plantscaping" was undertaken in the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara during 2010- 2012 with the objectives of evaluating the performance of foliage ornamentals under two growing conditions and to assess their potential for interior plantscaping.

The study comprised of four experiments involving evaluation of the performance of foliage ornamentals under two growing conditions with different ventilation systems, assessing their Air Pollution Tolerance Index (APTI), assessing their potential for interior plantscaping and finding their ability to remove air borne microbes and dust from indoors. The selected foliage plants were grouped into rosette, tree-like, flowering, upright, grass-like and climbing and trailing based on their growth habit.

The salient findings of the study could be summarised as follows:

1. The growing system with fan and pad was found to be the best compared to the system with natural ventilation for most of the quality characters of foliage plants.
2. Among the rosette type, with regard to the performance under the two growing structures, no significant difference was observed in most of the characters. So they could be recommended to grow under both the structures. As far as interior plantscaping is concerned, *Anthurium crystallinum, Calathea zebrina, Philodendron wendlandii* and *Homalomena wallisii* were found to be good to keep under various indoor conditions. Most of these rosette species were found compact in nature and they can be recommended for indoors with minimum spaces.
3. For tree-like plants, the fan and pad system was found to be more suitable than open ventilation system considering most of the suitable characters. Among the species, *Chrysalidocarpus lutescens*, *Codiaeum variegatum* 'Punctatum aureum', *Ficus benjamina*, *Licuala grandis*, *Rhapis excelsa* and *Schefflera arboricola* were observed to have good qualities for indoor. These tree-like species can be recommended for decorating bigger indoor places like marriage halls, indoor stadiums etc.
4. In flowering plants, there is no significant difference between the ventilation systems when the growth characters were concerned but in fan and pad system the flowering period of most of the species were extended and also the flower quality was better.

Anthurium andreanum 'Bonina' and *Spathiphyllum wallisii* were highly recommended for any indoor conditions. To some extent, *Kalanchoe blossfeldiana* could also be recommended.

5. Among upright plants, fan and pad system was found good for most of the growth characters. *Aglaonema pseudobracteatum*, *Dieffenbachia amoena*, *Sansevieria trifasciata* 'Laurentii', *Dracaena* 'Purple Compacta', *Peperomia obtusifolia* 'Sensation' and *Zamioculcas zamiifolia* could be recommended for various indoor conditions. As these species were narrow in growth, space occupy by them would be minimum and also they provide elegant appeal to indoors.
6. In grass-like plants, there was no significant difference between the growing systems in most of the growth as well as quality parameters. *Ophiopogon jaburan* 'Variegata', and *Chlorophytum* 'Charlotte' could be recommended for their variegations and compactness. *Cyperus alternifolius* could also be recommended. These species could be recommended for places like aisles in groupings.
7. It was also found that open ventilation system was good for most of the characters in the climbing and trailing category of plants. *Scindapsus aureus*, *Syngonium podophyllum*, *Philodendron* 'Ceylon Gold' and *Philodendron elegans* were the best to be recommended for indoor places like staircase, balcony etc.
8. When the APTI was concerned, it was found that the foliage plants significantly differed in their tolerance levels to air pollution and their tolerance differed based on the season. During March-April, the highest and the lowest APTI values were recorded in *Anthurium andreanum* 'Bonina' and *Aglaonema pseudobracteatum* respectively. During June-July, it was the highest in *Calathea zebrina* and the lowest in *Cyperus alternifolius* whereas during October-November, the highest and the lowest values were recorded in *Anthurium andreanum* 'Bonina' and *Syngonium podophyllum* respectively.
9. *Anthurium andreanum* 'Bonina', *Calathea zebrina* and *Dracaena* 'Purple Compacta' had the highest APTI value and was tolerant to air pollution irrespective of the seasons. In all the seasons, *Aglaonema pseudobracteatum*, *Kalanchoe blossfeldiana*, *Sansevieria trifasciata* 'Hahnii', *Spathiphyllum wallisii*, *Syngonium podophyllum*, *Tradescantia spathacea* 'Sitara' and *Zamioculcas zamiifolia* were found to be the most susceptible and they could be well utilized as indicator plants. Most of the remaining species could also be utilized in relation to their seasonal performance.

10. Based on the APTI values, ten foliage plants were selected and evaluated under various indoor light conditions. All the species performed well in medium light condition i.e., 800-2000 lux. In addition with that, *Anthurium andreanum* 'Bonina' performed well also in air conditioned zone. *Chrysalidocarpus lutescens*, *Philodendron* 'Ceylon Gold' and *Rhapis excelsa* had good performance also in high light condition (>2000 lux). In high and air conditioned zone, *Philodendorn elegans* and *Syngonium podophyllum* in supplementary and air conditioned zone had good performance. *Scindapsus aureus* was rated as the highest among all the species which scored 35.8 out of 50 with regard to all the concerned indoor qualities and also longevity in all light conditions tested.
11. Medium light condition (800-2000 lux) was found to be the best for all the foliage species and the condition could be well recommended for growing foliage plants under indoor conditions. Other light conditions were also could be considered for specific species. However, it is recommended that every plant should be shifted to outdoor conditions after a maximum period of two months for reclamation. So two sets of plants should be maintained for regular recycling.
12. In the experiment conducted at different zones of light intensities with and without plants to find out air borne microbes filtering efficiency of foliage plants, a significant amount of reduction of air borne microbes was observed in the zones with plants. The maximum amount of reduction (35.43 %) was recorded in the zone with medium light intensity with 127 Total colony forming units (Tcfu) without plants and 82 Tcfu with plants. It was closely followed by air conditioned zone with supplementary light which recorded 30.38 per cent reduction (from 79 Tcfu without plants to 55 Tcfu with plants).
13. Among the plants tested under indoor conditions for evaluating the efficiency for dust filtering, there was no significant difference between the species. However, the maximum amount of dust (3.57 g/m^2) was collected by *Syngonium podophyllum* and it was closely followed by *Philodendron elegans* with 3.14 g/m^2. Based on the ability to collect dust the species could be arranged in descending order as *Syngonium podophyllum* > *Philodendron elegans* > *Ficus benjamina* > *Philodendron* 'Ceylon Gold'> *Anthurium andreanum* > *Schefflera arboricola* > *Chrysalidocarpus lutescens* > *Rhapis excelsa* > *Spathiphyllum wallisii* > *Scindapsus aureus*.

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Appendix

APPENDIX I

Weather data of the open ventilated and fan and pad greenhouses

Months (Apr. '11 to March '12)	System I				System II			
	Temperature (°C)		RH (%)	Light (Lux)	Temperature (°C)		RH (%)	Light (Lux)
	Max.	Min.			Max.	Min.		
1	41.95	27.35	57.90	7694.16	36.41	27.17	83.45	4551.25
2	41.31	27.31	64.62	7186.31	32.75	24.91	95.79	3533.71
3	39.17	28.32	65.97	8263.33	32.28	24.41	95.88	4362.11
4	33.59	25.60	78.73	6380.67	33.29	24.80	96.29	4647.10
5	33.04	24.84	78.70	6346.20	35.18	24.55	93.07	5626.29
6	33.00	25.24	79.43	5458.21	36.16	25.15	90.24	5262.84
7	34.85	25.39	72.77	6422.17	33.05	23.52	85.80	4367.48
8	38.28	26.49	64.80	10938.92	32.56	22.49	83.18	4208.92
9	34.57	25.50	58.36	10837.98	33.94	21.33	81.39	4803.69
10	34.67	24.66	54.53	9560.42	36.70	22.09	76.48	4829.24
11	35.83	23.68	52.63	10915.31	36.41	25.34	84.70	5620.63
12	38.02	25.03	46.86	10961.35	35.76	25.81	88.45	6047.38

APPENDIX II
Weather data of the indoor experiment site

Weeks	Non air conditioned zone								Air conditioned zone				
	Temperature (^oC)		RH (%)		Light intensity (Lux)				Temperature (^oC)		RH (%)		Light intensity (Lux)
	Max.	Min.	Max.	Min.	LL	ML	HL	SL	Max.	Min.	Max.	Min.	
1	28.30	26.04	98.80	91.00	46.80	852.75	2079.00	891.25	25.83	22.38	88.00	64.25	1030.25
2	28.45	25.95	96.58	83.83	81.51	1201.08	2854.75	873.00	26.29	23.14	83.67	62.25	1166.33
3	27.74	26.15	98.13	90.88	79.13	929.88	2559.88	846.38	25.81	23.64	89.38	72.88	1018.25
4	26.98	24.80	99.00	95.25	109.25	649.42	1960.67	840.75	25.51	23.50	96.25	82.17	661.83
5	26.82	25.77	99.00	97.42	100.58	951.08	2736.08	817.42	25.19	23.44	93.67	79.58	811.75
6	26.91	25.72	98.90	94.20	55.90	1034.40	3099.00	760.40	25.68	23.68	93.60	75.60	845.30
7	26.43	25.53	99.00	98.33	34.75	775.42	1958.42	831.08	25.24	23.62	94.50	81.08	745.17
8	27.52	26.29	98.90	92.40	37.90	1015.70	3225.40	853.40	26.14	24.07	88.60	72.50	923.40
9	27.58	26.09	98.33	90.00	37.27	920.07	2536.13	849.93	26.09	23.91	88.40	70.33	818.67
Monthly mean													
1	28.53	26.23	98.00	87.78	63.04	1057.87	2366.38	871.13	26.34	22.43	87.44	63.67	1161.11
2	27.28	25.56	98.37	92.87	92.39	944.33	2669.17	840.57	25.63	23.45	91.59	75.26	863.00
3	27.23	26.00	98.76	93.37	36.00	882.29	2499.68	816.65	25.86	23.83	91.09	74.52	819.73

LL-Low light (<800 lux), ML- Medium light (800-2000 lux), HL- High light (>2000 lux), SL- Supplementary light without a/c (800-2000 lux), A/C- Supplementary light with a/c (800-2000 lux)

APPENDIX III

Weather data of Vellanikkara

Months	Temperature (°C)		Relative Humidity (%)		Sun-shine (hrs)	Rainfall (mm)	Number of rainy days
	Max.	Min.	Max.	Min.			
Jan. '11	32.7	22.2	76.2	40.6	8.5	0.0	0.0
Feb. '11	33.7	22.0	75.3	37.5	8.5	77.5	3.0
Mar. '11	34.8	23.9	85.0	43.2	8.7	10.0	2.0
Apr. '11	34.3	24.5	88.1	57.7	6.6	207.1	5.0
May. '11	33.0	24.9	90.6	63.0	6.8	198.5	7.0
June '11	29.3	23.6	95.5	82.4	2.5	799.6	27.0
July '11	29.1	22.9	94.8	80.8	1.6	588.2	26.0
Aug. '11	29.4	22.9	95.6	78.5	2.2	713.8	25.0
Sep. '11	30.0	23.1	94.2	74.7	4.4	435.2	15.0
Oct. '11	32.1	23.5	90.7	65.1	6.1	190.0	9.0
Nov. '11	31.4	22.9	79.4	56.8	6.3	240.0	9.0
Dec. '11	31.9	22.6	75.5	48.5	7.3	2.4	0.0
Jan. '12	32.8	21.3	75.2	39.9	9.5	0.0	0.0
Feb. '12	35.1	22.1	74.7	33.3	9.2	0.0	0.0
Mar. '12	35.2	24.2	86.4	49.4	7.6	4.5	1.0
Apr. '12	34.8	24.8	88.5	55.0	6.6	16.0	3.0

APPENDIX IV

Procedure for estimation of leaf chlorophyll, pH, RWC and ascorbic acid

TOTAL CHLOROPHYLL

Reagent required: 80 % acetone

Weighed 250 mg of fresh leaf sample and transfered to a mortar. Macerate the sample with 10 ml of 80 % acetone. Centrifuge the contents at 3000 rpm for 10 minutes. After centrifuging, collect the supernatants and make up the volume to 25 ml by using 80 % acetone. Measure the optical density at 645 and 663 nm by a spectro photometer.

Calculation

Total chlorophyll= 20.2 (A_{645}) + 8.02 (A_{663}) x (V/1000 x W) x 1000

LEAF EXTRACT PH

For leaf-extract pH, a 0.5 g leaf sample was homogenized with 50 ml de-ionized water and the pH of the suspension was measured with a photovolt pH meter, using a glass electrode.

RELATIVE WATER CONTENT

The third leaf (physiologically functional) from the top was selected for RWC estimation. Physiologically functional leaf samples were taken and made 50 uniform leaf discs. Recorded the fresh weight (Fw). Floated the leaf discs in water for one hour to attain full turgidity and after took out the leaf discs from water and wiped out the water droplets sticking on the leaf surface by using filter paper. Immediately recorded the turgid weight (Tw) after an hour of floating. Transfered the leaf discs to a butter paper cover and then kept the cover in hot air oven at 80°C for 4 hours. Recorded the dry weight (Dw). Calculated the RWC by using the following formula:

RWC = (Fw-Dw / Tw- Dw) x 100

ESTIMATION OF ASCORBIC ACID

Materials required:

4% Oxalic acid solution

0.5N Sulphuric acid. (Dilute 1.36ml of conc. H_2SO_4 to 100ml of water)

2% 2,4 Dinitrophenyl Hydrazine (DNPH) reagent. Dissolve by heating 2g DNPH in 100ml 0.5N H_2SO_4. Filter and use.

10% Thiourea solution.

80% Sulphuric acid

Bromine water. Dissolve 1-2 drops of liquor bromine in approximately 100ml cool water.

Ascorbic acid stock standard solution: 100 mg ascorbic acid dissolved in 100ml of 4% oxalic acid solution in a standard flask (1mg/ml)

Working Standard: Diluted 10ml of the stock solution to 100ml with 4% oxalic acid. The concentration of working standard was 100µg/ml.

Extraction

0.5g of sample material was ground using a pestle and mortar in 10ml 4% oxalic acid solution. Then centrifuged and collected the liquid.

Transferred the aliquot to a conical flask and added bromine water drop wise with constant mixing. The enolic hydrogen atoms in ascorbic acid were removed by bromine. When the extract turns orange yellow due to excess bromine, expelled it by blowing in air. Make up to a known volume (25ml) with 4% oxalic acid solution.

Similarly, converted 10ml of standard stock ascorbic acid solution into dehydro form by bromination. Then diluted it to 100ml with 4% oxalic acid for working standard (100µg/ml)

Procedure

1. Pipetted out 0.1-1.0ml (10-100µg) working standard into a series of test tubes
2. Similarly pipetted out 1ml aliquot of brominated sample extract
3. Made the volume in each tube to 3ml by adding distilled water
4. Added 1ml of DNPH reagent followed by 1-2 drops of thiourea to each tube.

5. Set a blank as above but with water in place of ascorbic acid solution.
6. Mixed the contents of the tubes thoroughly and incubated at 37°C for 3h (1h).
7. After incubation dissolved the orange-red osazone crystals formed by adding 7ml of 80% sulphuric acid.
8. Measured absorbance at 540nm.
9. Plotted a graph ascorbic acid concentration versus absorbance and calculated the ascorbic acid content in the sample.

Calculaticn

For example,

From the graph, 0.017 = 30 μg

i.e 1ml contains = 30 μg

25ml contains = 30/1 x 25

i.e 500mg (0.5g) contains = 30/1 x 25

therefore, 1g contains = 30/1 x 25 x 1000/500 x 1/1000

= 1.5 mg/g of ascorbic acid content

0.5 N of sulphuric acid

Assume, required volume: 100ml (0.1 litre)

Formula:

Grams of compound needed= (N desired) (**equivalent mass**) (vol. in litres desired)

= (0.5) (49) (0.1)

= 2.45 g of H_2SO_4

Volume of concentration acid needed= gram of acid needed/ (percent conc. X sp. gravity)

= 2.45 / (0.98 x 1.84)

(percent conc. & sp. gravity would be in the chemical bottle)

= 1.36 ml

Therefore, **1.36 ml** of conc. Sulphuric acid diluted in 100ml water will give 0.5N H_2SO_4

[**Equivalent mass**= compound's gram molecular mass/ No. of H^+ ions or OH^- ions

For H_2SO_4

Gram molecular mass= 98

H=1, S= 32, O= 16

H_2SO_4 = (1 x 2) +32 + (16 x 4) = 98, No. of H^+ ions = 2,

Therefore, equivalent mass of H_2SO_4 = 98/2 = **49**]

EVALUATION OF FOLIAGE PLANTS FOR INTERIOR PLANTSCAPING

By

ALEX, R

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

Doctor of Philosophy in Horticulture

Faculty of Agriculture
Kerala Agricultural University

Department of Pomology and Floriculture
COLLEGE OF HORTICULTURE
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2012

ABSTRACT

Studies were undertaken in Department of Pomology and Floriculture, College of Horticulture, Vellanikkara during 2010-2012 to evaluate the foliage plants for interior plantscaping. The study comprised of four experiments in which fifty foliage plant species were selected for evaluation under two growing structures having two different systems viz., open ventilated and fan and pad. Air Pollution Tolerance Index of all the selected species of foliage plants were computed and based on that, ten species was selected and their performance under different indoor light conditions was studied. The air borne microbes and dust filtering efficiency of these ten indoor foliage plant species were also evaluated.

When the growing structures, viz., open ventilated & fan and pad greenhouses were compared, the plants kept in fan and pad system were found to be superior than the plants kept in open ventilated greenhouse with regard to most of the characters. So the fan and pad system could be considered as the best for growing the foliage plants. But precautions should be taken to check the humidity levels.

Fifty selected species of foliage plants were classified into six categories namely rosette, tree-like, flowering, upright, grass-like and climbing and trailing based on their growth habit. Among the rosette type, *Anthurium crystallinum, Calathea zebrina, Philodendron wendlandii and Homalomena wallisii* could be recommended for their compactness. *Chrysalidocarpus lutescens, Codiaeum variegatum 'Punctatum aureum', Ficus benjamina, Licuala grandis, Rhapis excelsa and Schefflera arboricola* could be recommended among the tree-like species which could be utilized to decorate bigger indoor places. In flowering foliage plants, *Anthurium andreanum 'Bonina', Spathiphyllum wallisii* and *Kalanchoe blossfeldiana* could be recommended for any indoor conditions as they would improve the interior environment with their attractive flowers as well as foliages. *Aglaonema pseudobracteatum, Dieffenbachia amoena, Sansevieria trifasciata 'Laurentii', Dracaena 'Purple Compacta', Peperomia obtusifolia 'Sensation' and Zamioculcas zamiifolia* could be recommended in upright foliage plants. Among grass-like species, *Cyperus alternifolius, Chlorophytum* 'Charlotte' and *Ophiopogon jaburan* 'Variegata' were found to be good and recommended to place them in groupings. Among climbing and trailing plants, *Scindapsus aureus, Syngonium podophyllum, Philodendron 'Ceylon Gold'* and *Philodendron elegans* were found best and recommended for places like staircase, balcony etc.

The Air Pollution Tolerance Index (APTI) of the foliage plant species under the study was computed for three different seasons, *viz*., March-April, June-July and October-November and based on this they were categorized into sensitive, intermediately tolerant, moderately tolerant and tolerant. It was observed that *Anthurium andreanum* 'Bonina', *Calathea zebrina* and *Dracaena* 'Purple Compacta' had the highest APTI value and was tolerant to air pollution irrespective of the seasons. In all the seasons, *Aglaonema pseudobracteatum*, *Kalanchoe blossfeldiana*, *Sansevieria trifasciata* 'Hahnii', *Spathiphyllum wallisii*, *Syngonium podophyllum*, *Tradescantia spathacea* 'Sitara' and *Zamioculcas zamiifolia* were found to be the most susceptible and they could be recommended to be used as indicator plants for pollution. Other species could also be utilized based on their tolerance levels with respect to the seasons.

Based on the APTI value, ten species were selected (two from each category) and their performance was studied under five different indoor light conditions viz., low (<800 lux), medium (800-2000 lux), high (>2000 lux), supplementary (800-2000 lux) and supplementary light with air condition. From the results, it was found that most the foliage plants could thrive well under medium light condition. In addition with that, under air conditioned zone with supplementary light, species like *Anthurium andreanum* 'Bonina', *Philodendron elegans* and *Syngonium podophyllum* could be recommended. Species like *Chrysalidocarpus lutescens*, *Rhapis excelsa* and other palms could be recommended for areas with high light intensity. The performance of *Scindapsus aureus* was found good with regard to almost all the desirable characters in all the light conditions.

The foliage plants were found very effective in reducing air borne microbes present in indoor conditions. The maximum amount of reduction (35.43 %) was recorded in the zone with medium light intensity where there were 127 Total colony forming units (Tcfu) without plants, which was reduced to 82 Tcfu when foliage plants were kept under the same zone. Regarding the dust filtering efficiency, the maximum amount of dust (3.57 gm^{-2}) was found to be removed from the atmosphere by *Syngonium podophyllum*. Based on the amount of dust collected by the species, they could be arranged as *Syngonium podophyllum* > *Philodendron elegans* > *Ficus benjamina* > *Philodendron* 'Ceylon Gold'> *Anthurium andreanum* > *Schefflera arboricola* > *Chrysalidocarpus lutescens* > *Rhapis excelsa* > *Spathiphyllum wallisii* > *Scindapsus aureus*.